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Local Marine Board

EXAMINATION,

FOR OFFICERS

IN THE

Mercantile Marine Service.

INCLUDING:

REGULATIONS FOR MASTERS AND MATES,
IN FOREIGN AND COASTING TRADE; RULES
OF THE ROAD, LIGHTS, LAWS OF
STORMS, QUESTIONS IN SEAMANSHIP,
NAVIGATION, STEAM, &c., &c.

ALSO:

A SERIES OF EXPLANATORY LECTURES
ON NAVIGATION AND ASTRONOMICAL TERMS.

BY

CAPT. ERASMUS THOMPSON,

OF THE

BOSTON NAUTICAL COLLEGE.

1868.

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Printed by J. A. CUMMINGS & Co., 15 School Street, Boston.

PREFACE.

THIS work is intended for a hand book for the Marine Board Examination, and will commend itself to those desirous of making themselves thoroughly competent to pass the Local Marine Boards. It contains the questions and exercises in Navigation and Seamanship requisite for the different grades in the profession; also Rules of the Road, Examination in Steam for Commanders and First Officers of Ocean Steamers; the importance of every navigator thoroughly understanding the Laws of Storms, and some few general rules given for Hurricane Latitudes. It will contain instruction for the young officer in stowing cargoes, with the questions for the same; questions in regard to Laws of Shipping, Charter parties, Bills of Lading, Bottomry Bonds, &c., &c. Also a general knowledge of the requirements necessary for a Master or Mate, and a series of Lectures on Navigation; the whole carefully considered and compiled, by

CAPT. E. THOMPSON.

Boston Nautical College.

EXAMINATION OF MASTERS AND MATES

OF

Foreign-going and Home Trade Passenger Ships,

AND

EXAMINATION IN STEAM FOR OFFICERS.

Under the Provisions of a Bill now before the Senate and House of Representatives of the United States, in Congress Assembled, 1868, 40*th Congress*, 2*d Session*, *H. R.* 947.

"No foreign-going ship, or home-trade passenger ship, can obtain a clearance, or legally proceed to sea, from any port in the United States, unless the Master thereof, and in case of a foreign-going ship, the first and second Mates or only Mate, (as the case may be,) and in the case of a home-trade passenger ship, the first and only Mate, (as the case may be,) have obtained and possess valid certificates, either of competency or service, appropriate to their several stations in such ship, or of a higher grade; and *no ship of one hundred tons burden and upwards*, can legally proceed to sea unless *at least one officer*, besides the Master, has obtained and possesses a valid certificate of Mate, or of a higher grade.—And every person who, having been engaged to serve as Master, or as first, or second, or only Mate, of any foreign-going ship, or as Master, or first, or only Mate of a home trade passenger ship, goes to sea as such Master or Mate, without being at the time entitled to and possessed of such certificate as the act requires, or any one who shall employ any person as Master, or first, second, or only Mate of any foreign-going ship, or as Master, or first, or only Mate of any home-trade passenger ship, without ascertaining that he is at the time entitled to and possessed of such certificate, *for each offence incurs a penalty not exceeding one thousand dollars.*

SEC. 6. Every certificate of competency for a foreign-going ship shall entitle the holder thereof to go to sea in the corresponding grade, in a home-trade, passenger or coasting ship; but *no certificate* for a *home-trade, passenger or coasting* ship shall entitle the holder thereof to go to sea as *Master* or *Mate* of a *foreign-going ship.*"

Qualifications for Certificates of Competency for Foreign-going Ships.

A SECOND MATE

Must be over seventeen years of age, and must have been three years to sea.

IN NAVIGATION.

He must write a legible hand and understand the first four rules of Arithmetic, and he must also be able to keep a log, correct the courses steered for variation and leeway, find the difference of latitude and longitude therefrom, be able to correct the suns declination, and find his latitude by meridian altitude of the sun. He must understand the use of the quadrant, and be able to observe with it and read off the arc.

IN SEAMANSHIP.

He must give satisfactory answers as to the rigging and unrigging of ships, stowing of holds, &c., measuring log and lead line, be conversant with the Rules of the Road as regards both steamers and sailing vessels and the lights carried by them.

A FIRST MATE

Must be seventeen years of age, and have been to sea three years.

IN NAVIGATION.

In addition to the qualifications required of a Second Mate, he must be able to work course and distance by Mercator's method; be able to observe and calculate the amplitude and azimuth of the sun, and find the variation of the compass therefrom; he must know how to lay off the place of the ship on the chart, both by cross-bearings and by latitude and longitude; to find his longitude by chronometer, and be able to use and adjust the sextant, and find the errors of the instrument.

IN SEAMANSHIP.

In addition to what is required of a Second Mate, he must know how to moor and unmoor, and to keep a clear anchor, stow anchors, &c., shift large spars and sails, manage a ship in stormy weather, take in and make sail, step masts, &c., get cargo in and out, especially heavy weights, anchors, &c.

A MASTER

Must be twenty-one years of age, and have passed through the grades of mate, and in addition to the qualifications of a First Mate, he must be able to find the latitude and longitude by the moon and planets; method of determining the local errors of the compass; will be required to enter and discharge at the custom-house; have a knowledge of the nature of a bottomry, invoices, charter-party, ships accounts, &c., &c.

AN EXTRA FIRST CLASS MASTER.

This examination is for such officers as wish to prove their superior qualifications, and is intended for commanders of first class passenger ships and steamers.

IN NAVIGATION.

In addition to the qualifications of Master, he will be required to work double altitudes, circum-meridian altitudes, lunars, both by sun and stars, and be able to calculate the altitudes, and work Sumner's method. He must also be acquainted with the laws of storms.

IN SEAMANSHIP.

The extra examination will consist of heaving a ship down for repairs in case of accident befalling her abroad; to get in lower masts or any other heavy weights; explain the various evolutions of working ship; club-hauling off lee shore, and such operations of a like nature as the Examiners may consider necessary.

Qualifications for Certificates for Coasting or Home-Trade Passenger Vessels.

A MATE

Must write a legible hand and understand the first four rules of arithmetic; he must know and understand the Rules of the Road; keep a log; be able to take bearings by compass, also cross-bearings; prick off the ship's course on the chart; he must know how to mark a lead and log line and use the same.

A MASTER,

In addition to the qualifications required for a mate, must be capable of navigating a vessel along any coast; he will be required to lay off on the chart the course and distance he has run along shore from headland to headland, and correct these courses for leeway and variation; also to give the bearings of these headlands and lights; when the courses should be altered, either to clear any danger or to adapt it to the coast; he must also understand how to make his soundings according to the state of the tide.

General Rules as to Examination and Fees.

Candidates *may* be allowed to work out the various problems, or they *may* be required to *write out* the examination, as the Local Marine Board may decide.

FEES.

For certificate of Master, - - - - - -	$10 00
For certificate of Mate, - - - - - -	5 00

Which fees will constitnte a fund for defraying the expenses of such examinations.

ANY ONE,

Who has been one year in possession of a Mate's or Master's certificate, may pass an *extra examination*, and receive an extra certificate in exchange for his former one, by the payment of three dollars.

And should an applicant be examined for a higher rank and fail, but pass an examination of a lower grade, he can receive a certificate accordingly, but no part of the fee will be returned.

And "any person who shall make, or assist, or procure to be made, any false representation for the purpose of obtaining for himself, or for any other person, a certificate of competency, or who shall fraudulently alter, or assist, or procure to be fraudulently altered, any such certificate, or who shall make use of any such certificate, which is forged, altered, cancelled or suspended, or who shall fraudulently lend his certificate, or allow the same to be used by any other person, shall for every such offence, be deemed guilty of a misdemeanor, and be punished on conviction by fine or imprisonment."

And "every applicant for examination must furnish *satisfactory evidence* of his *sobriety*, *experience*, *ability*, and *general good conduct* on ship-board."

And "whenever any Master or Mate shall prove satisfactorily to any board of examiners, that he has without fault on his part, lost or been deprived of any certificate already granted to him, a copy of the certificate to which he may be entitled shall be made out and delivered to him upon the payment of a fee of two dollars."

EXAMINATION OF MASTERS AND MATES.

As these Examinations are made compulsory, it will be very advantageous for officers and those wishing to become so, to employ their leisure hours, when in port, in the acquirement of the knowledge necessary to enable them to pass their examinations. Masters, Mates and junior officers are therefore strongly urged to attend the Boston Nautical School to obtain this necessary instruction, so as to enable them to pass with credit to themselves and honor to the craft.

A MASTER'S DUTIES IN RELATION TO

PASSENGERS.

The Master must see to it personally that his passengers have reasonable food, comforts, necessaries and kindness.—And in respect to females the law extends still further, and includes an implied stipulation against obscenity, immodesty and a wanton disregard of feelings.

OFFICERS.

A Master may remove either of his officers from duty for gross negligence and disobedience, or for incapacity; but the causes of removal must be strong and evident, more so in the case of the chief mate than any other officer. Nothing but evident unfitness, or gross and repeated misconduct will justify the Master in turning a person forward who shipped in another capacity, such as mate, carpenter, steward or cook, &c.

CREW.

The Master of every vessel of the United States, bound on a foreign voyage, and all coasting vessels of fifty tons burden, must make a contract in writing, (shipping articles,) with each seaman and officer, specifying the voyage, terms, &c.; and in default thereof, shall forfeit 20 dollars for every case, and shall pay every such seaman the highest rate of wages out of port.

DOCUMENTS.

It is the duty of the Master to take to sea with him a certified copy of the list of his crew, and shipping articles. If going on a foreign voyage, a *certificate of Registry*, a passport, sea letter, bill of health, general clearance, clearing manifest, bill of lading, charter party, (if one is given,) invoices and log book. On entering at the custom house, the Master is required to have a manifest, list of passengers and crew, and also of all the remaining sea stores; and on arriving at a foreign port, must deposit with the consul his register, sea letter and passport, which will be returned to him by the consul upon his obtaining a clearance.

"On returning to the United States, he must deliver to the collector a list of his passengers, names, age, sex, occupation and country to which they belong; must have manifest of cargo made out, and ready to deliver to any officer of the customs who may come on board within four leagues of the coast; and any Master refusing to exhibit his manifest or deliver a copy of the same to the boarding officer, or inform him of the true destination of the vessel, forfeits five hundred dollars. He must also deposit all his letters at the post office, except such as are directed to the owner or consignee of the vessel, before entering his cargo, and if he breaks bulk before depositing his letters, he forfeits one hundred dollars for each offence. He must report himself to the collector within twenty-four hours. Should he attempt to leave port without entry he forfeits four hundred dollars."

And the Master is bound to observe the revenue laws of whatever country he may be in. "And he has not, like the seaman, a lien on the ship for his wages, but must proceed against the owner personally for any such debt. The power of procuring loans or advances upon a bottomry bond is one of the most delicate powers entrusted to the Master, and one which he cannot exercise except under peculiar circumstances. And he can only hypothecate the ship, (that is give a bottomry bond,) in a foreign port, in the absence of the owners; and he should always consult the owners, if he can do so without any great loss of time, before attempting to raise money upon bottomry. And if a Master cannot supply the wants of the vessel, either upon the credit of the owners, or by hypothecating the ship, he may then sell a part of the cargo or hypothecate the whole.

A Master should enter a *general protest* to be extended on afterwards, immediately after arriving in port. This protest should be against all losses, damages and misfortunes which may happen to the vessel or cargo in the course of the voyage. And should he be driven by stress of weather, out of the regular course of the voyage, he is *bound* to enter his protest at the first port he may arrive at; and all protests must be made within *twenty-four hours* after his arrival in port. And should he find that the ship or cargo had sustained damage, he can then extend his general protest and take out a writ of survey within twenty-four hours, which must be given to one of the port surveyors, who will examine the storage, and he must see the hatches opened before the bulk is broken; otherwise, the ship will be accountable for the damaged goods.

MATE'S DUTIES.

In case of absence, incapacity, or death of the Captain, the command and responsibility devolves on the Mate, for Marine Law recognizes the first officer of a ship as second Captain, competent in all respects to take his place in case of accident to the first Captain. It is therefore of the utmost importance that every vessel should have on board a Mate having sufficient practical knowledge of navigation and seamanship to take command in case of necessity; and under the new regulations, any vessel sailing foreign without such a Mate will not be deemed sea worthy. Should the Master become incompetent during the voyage, or insane, or otherwise incapable of discharging the duties of his office, it is the duty of the Mate to assume the command of the vessel; but to justify the Mate in taking command, the Master must be clearly incompetent to dischage his duties, as in case of sickness, or becoming insane, &c.

The duty of the Mate is to attend to the taking in and delivery of the cargo. While at sea, he superintends the work and sailing of the vessel, and his orders must be promptly obeyed by the crew as if coming from the Master. And it is his duty to keep the Log Book and allow *no one* to make an *entry therein but himself*, which log must be a correct and minute journal of the voyage, containing everything of local interest to his owners and underwriters; it should contain an accurate account of the ship's course, with a short history of every occurrence during the voyage, as these statements in the Log Book are of the utmost importance in settling questions of general average, insurance, salvage and other controversies.

SEAMEN'S DUTIES.

The seaman engages for the faithful performance of the service for which he contracted. The *Master* has the power of punishing the seaman for negligence, or disorderly, or disobedient conduct; "But he must also treat his seaman with decency and kindness, and protect him against abuse or ill-treatment of his officers. And if any Master shall from malice, hatred, or revenge, or without cause, beat, wound, or imprison any one of his crew, or withhold from him suitable food and nourishment, he shall be punished by a fine, not exceeding one thousand dollars." "And any seaman, after having signed the shipping articles and received his advance, if he then refuses to proceed on the voyage, the captain or owner may have such seaman committed to the common jail, there to remain till he shall have paid double the amount of his advanced wages and the reasonable costs of committal. And when the ship is at sea, it is no excuse for the refusal of a seaman to do his duty, that she was unseaworthy when she sailed. *He is bound* in such case to perform his duty faithfully and diligently; and in time of peril, to exert *himself* to the *utmost* to save both the ship and cargo. Nor can he refuse to proceed to sea from a dislike to the Master, or because a new Master has been appointed. During the voyage, he must render a prompt obedience to the lawful commands of the Master; and he must conduct himself in an orderly and respectful manner. And in port, should he absent himself without leave, he forfeits three days pay for every day's absence; and if absent more than forty-eight hours at one time, it is deemed desertion, and is punished by a forfeiture of all his wages then due."

If shipping articles are not signed by a seaman for a voyage, he may leave the ship at any time and claim the highest wages out of port.

"And any person harboring or secreting a seaman belonging to any vessel, knowing him to belong thereto, he shall pay ten dollars for every day he harbors or secrets such seaman. And no sum exceeding *one dollar* can be recovered from any seaman for debt contracted while he belongs to any vessel." And seamen are bound to take care of the vessel and *assist* in the *stowage* and *delivery* of the cargo, at the several ports described in the shipping articles. Nor is the duty of the seaman finished when the vessel has arrived at home; he must assist in discharging the cargo unless there is an express or implied agreement, but when it is an established custom of the port to discharge the seamen before unlading the vessel, they are not bound to remain unless directed to do so by the Captain.

"No seaman can be confined in prison in a foreign port, except in *extreme cases*, and when the proper correction cannot be effectual on board. Nor are his wages forfeited by imprisonment."

And when a seaman ships for a particular duty, and is found to be unqualified for that duty, the Master can put him to a *different service* and deduct from his wages. Thus the seaman will see that the *law* requires him to conduct himself in an orderly and honest manner, to be diligent in his duty and obedient to all the lawful commands of the Master.

EMIGRANT PASSENGER LAW.

"No Master of any vessel owned by a citizen of the United States, or by a citizen of any foreign country, shall take on board such vessel, at any foreign port or place, a greater number of passengers than in proportion of one to every two tons of such vessel, computing two children, over one and under eight years of age, as one passenger.

And the space appropriated for the use of passengers, shall not be occupied by stores or other goods; and no passenger shall be carried upon any deck where the hight or distance between decks is less than *six feet*.

And any Master who shall take on board any greater number of passengers than in the proportion aforesaid, shall be deemed guilty of a misdemeanor, and upon conviction, shall for each passenger taken beyond the limit, be fined the sum of fifty dollars and imprisoned not exceeding six months.—And no vessel shall have more than two tiers of berths, and the berths shall be well constructed, and separated from each other by partitions, and shall be six feet in length and at least two in width; and each berth shall be occupied by no more than one passenger; but double berths of twice the above width, may be constructed to be occupied by no more than by two persons, either a man and wife or woman and two children, and shall there be any violation of this section, the Master of the vessel and the owners shall forfeit and pay the sum of five dollars for each passenger on board.

And the Captain is authorized to maintain good discipline, and such habits of cleanliness among the passengers as will tend to the preservation and promotion of health; and he shall cause such regulations as he may adopt for this purpose to be posted up, before sailing, on board, and shall keep the same posted during the voyage; and it is also his duty to cause the apartments occupied by such passengers to be kept clean and in a healthy state. And he shall also deliver to the collector a passenger manifest, and designate the age, sex and occupation of said passengers, and the part of the vessel occupied by each during the voyage and the country to which they severally belong; he must also state what number have died on the voyage; which manifest must be sworn to by the Master in the same manner as the manifest of the cargo."

LAW OF STORMS.

The object of the following remarks on revolving storms, is to exhibit the importance of gaining such knowledge of the Law of Storms that the commander of a vessel may know instinctively what part of a cyclone he may be in; and for this nothing more is requisite than that he possess a competent knowledge of the bearing of the centre from the ship, as determined by the direction of the wind, and the result of the hauling of the wind with or against the sun, as indicating on which side of the axis line he may be placed; the axis line coinciding with the path of the centre. With this knowledge and the barometer, a commander may determine with perfect accuracy on which tack to heave too so as to draw out of the storm.

There are several published works on this important subject, the most noted of which is Reid's Law of Storms, which should be in the possession of every ship-master and every officer. In this article I purpose only to give an outline of the laws that govern storms, and the navigator will find in the work I mention all the information and instruction requisite for him to know, and which will be of great importance to him.

The primary idea of a *cyclone*, is that of a vast body of air in a state of rotation, more or less rapid. This rotation appears to be immediately connected with the rotation of the Earth, or rather with the apparent course of the sun in the heavens, arising from the Earth's rotation on its axis. The rotation of the air around the axis of the cyclone, producing the hurricane wind, is always contrary to or against the apparent course of the sun, and as the apparent course of the sun is reversed in the opposite hemispheres, so the rotation of the air in the cyclone is in opposite directions on either side of the equator. Thus a very simple rule is deducible from these interesting facts. In the northern hemisphere the cyclone rotates in a direction contrary to that in which the hands of a clock move, but in the southern hemisphere the rotation coincides with the hands. This whirling of the air in a cyclone, enables us to characterize certain portions of the storm by certain hurricane winds. Thus in the northern hemisphere the *northern* margin of the storm always exhibits an *easterly* wind, the *eastern* margin a *southerly* wind, the *southern* margin a *westerly* wind, and the *western* margin a *northerly* wind. This arrangement of the winds in a hurricane will conduct us to a very simple rule for determining the position of a vessel in a cyclone, and, as a consequence, the bearing of the centre of the storm from the ship. From the easterly wind in the northern hemisphere, the centre will bear south, or eight points, reckoned in the same direction as the apparent course of the sun; an easterly wind characterizing the northern margin. From a northerly wind the centre will bear east, from a westerly wind it will bear north, from a southerly wind west. Thus the direction of the wind only in a revolving storm will announce to the commander of the vessel two very important points: his exact position in the cyclone, and the bearing of its centre from his ship; and the same simple and plain rule holds good in the southern hemisphere. From an easterly wind, the centre of the storm bears *north*, or *eight* points, reckoned in the same direction as the apparent course of the sun, the sun rising in the east, culminating in the north, and setting in the west. From a southerly wind the centre bears *east;* from a westerly, *south;* and from a northerly, *west.* These bearings are precisely the reverse of those in the northern hemisphere, but as the apparent motion of the sun is also reversed, the rule is applicable to both hemispheres. That the centre of a revolving storm bears eight points from the direction of the wind at the ship, reckoned with the apparent course of the sun.

As a vessel approaches a storm, a dense, dark wall or bank of clouds appear to advance and draw down closely upon the ship, so that she becomes involved; and they present so appalling an aspect, they appear to be so close to the vessel and so solid in their structure, that a commander may almost fancy he can, from the vessel, put his hand upon them. And when the ship approaches so near the cyclone as to experience the effect of the outward gyration, the weather becomes still more significant; the proper wind of the hurricane, generally characterized as stormy and squally, carries over the vessel portions of the great bank of clouds peculiar to the storm; these portions are torn into rags and shreds, while the bank still marks the locality of the cyclone. From this point a run of a few hours *toward* the centre will generally involve a ship in an impetuous and terrific hurricane. Frequently, a short time before one of these visitants bursts on the ship, the sky presents a lurid, threatening aspect, the atmosphere becomes oppressive and sultry, the clouds vary from a deep and angry red to a peculiar heavy olive; in such cases the cyclones are very destructive. A rule of considerable importance in manœuvering a vessel, when overtaken by a storm of a revolving character in the northern hemisphere, is if the ship receive the wind on her *port* side her head is directed more or less *towards* the centre of the cyclone; but if she receive it on her *starboard* side, her head is turned *away* from the centre. These facts readily indicate the means to be adopted, either to retire to or beyond the margin of the storm, or to draw from the centre when lying too.

The Barometer is an invaluable instrument in a cyclone; it announces to the commander his approach to the vicinity of a revolving storm; it advertises him of his plunging into its vortex; it acquaints him with his recess from the centre, and by carefully noticing its indications he may avoid the disastrous consequences of a hurricane; for the laws of its oscillations in a cyclone are distinctly marked.

And he who watches his barometer watches his ship. For when the first half of a storm passes a ship the barometer will fall, and when the succeeding half passes it the barometer will rise. In keeping just within the verge of a storm, the barometer is of signal benefit, as by keeping it as high as possible without losing the cyclone winds, the vessel will be kept just within the margin, and in whatever position the ship may be, the rising of the mercury announces that the first half has passed.

The hurricane season generally sets in, in the North Atlantic, as the sun is leaving the tropic of Cancer, shortly after the summer solstice, and continues until he has passed to some distance south of the equator. The cyclone months are July, August, September and October; also November and December. During the month of July, hurricanes are rare in the part of the Atlantic navigated by vessels bound to Europe, but in the months of August and September the tracks of most ships lie in the district where the paths of the centres of cyclones are most numerous.

A writer in the Journal, speaking of ocean storms, truly says that

"One of the most fearful things in nature is a storm upon the ocean. Only during an earthquake is human strength more utterly set at nought. Upon the land there is comparative security, even during the severest gales, while on the ocean only a few planks intervene between life and death. While the earthquake, however, is disastrous chiefly in a limited region, the wind flies on its career of destruction over the whole vast expanse of waters on the globe, and a far greater number of the earth's inhabitants have a dread of storms upon the sea, than of those who fear the throes of the earthquake. Single earthquakes have destroyed more lives than any single hurricane upon the ocean was ever known to, as the great Sicilian earthquake of 1693, by which one hundred thousand persons lost their lives, or the two earthquakes which occurred at Antioch in the years 526 and 612, which together destroyed three hundred thousand persons; but the aggregate loss of life by gales at sea is much larger, earthquakes are so infrequent and storms so common and disastrous. In the spring of 1866 there might be seen at a single view, from the hights near Plymouth, England, twenty-two shipwrecked vessels, and this after a storm which, though severe, was but trifling compared with some gales which pass over tropical regions. In the great hurricane of 1780, which began at Barbadoes and swept across the whole breadth of the North Atlantic, fifty sail were driven ashore at the Bermudas, two line-of-battle ships went down at sea, and upwards of twenty thousand persons lost their lives on the land. In the gale of August, 1782, three thousand lives were lost at sea. In October, 1864, a fearful gale swept over the Bay of Bengal, all the ships in the harbor at Calcutta were swept from their moorings, and the loss of life and property was very great. A vast wave swept for miles over the surrounding country, and whole villages with their inhabitants were engulfed. Fifty thousand souls, it is believed, perished in this fearful hurricane. The tornado which swept over the West India Islands a few months ago is another mournful illustration of the terrific power of the wind.

"The laws which seem to govern these cyclonic storms are treated in a very interesting manner by a recent writer in *Temple Bar*. The regions chiefly infested by them are the West Indies, the southern part of the Indian Ocean, the Bay of Bengal, and the China seas. Each has its special hurricane season. In the West Indies cyclones happen principally in August and September, when the southeast monsoons are at their hight. At the same season the African southwesterly monsoons are blowing. Accordingly there are two sets of winds, both blowing heavily and steadily from the Atlantic, disturbing the atmospheric equilibrium, and thus in all probability generating the great West India hurricanes. The storms begin about six or seven hundred miles from the equator, and far to the east of the region where they attain their greatest fury. They sweep with a northwesterly course to the Gulf of Mexico, pass thence northwards, and so to the northeast, sweeping in a wide curve (like the letter U placed on its side ⊂) around the West India seas, and thence travelling across the Atlantic, generally expending their force before reaching the shores of Europe. The hurricanes of the Indian Ocean occur at the changing of the monsoons. During the interregnum the fiends of the storm hold their terrific sway. Becalmed, often, for a day or two, seamen hear moaning sounds in the air, forewarning them of the coming storm. Then the winds break loose and rage with fury. In the North Indian seas hurricanes rage at the same season as in the West Indies. In the China seas occur those fearful gales known among sailors as typhoons, or white squalls. These take place at the changing of the monsoons. In regard to the motions of cyclones, the writer remarks:

" 'It is found, by a careful study of different observations made upon the same storm, that cyclones in the northern hemisphere *invariably* sweep round the onward traveling vortex of disturbance in *one* direction, and southern cyclones in the contrary direction. If we place a watch-face upwards upon one of the northern cyclone regions in a Mercator's chart, then the motions of the hands is *contrary* to the direction in which the cyclone whirls; when the watch is shifted to a southern cyclone region, the motion of the hands takes place in the same direction as the cyclone motion. This peculiarity is converted into the following rule-of-thumb for sailors who encounter a cyclone, and seek to escape from the region of fiercest storm: *Facing the wind, the centre or vortex of the storm lies to the right in the northern, to the left in the southern, hemisphere.* Safety lies in flying from the centre in every case save one—that is, when the sailor lies in the direct track of the advancing vortex. In this case, to fly from the centre would be to keep in the storm-track; the proper course for the sailor when thus situated is to steer for the calmer side of the storm-track. This is always the outside of the ⊂, as will appear from a moment's consideration of the spiral curve traced out by a cyclone. Thus, if the seaman *scud before the wind*—in all other cases a dangerous expedient in a cyclone*—he will probably escape unscathed. There is, however, this danger, that the storm-track may extend to or even slightly overlap the land, in which case scudding before the gale would bring the ship upon a lee-shore. And in this way many gallant ships have, doubtless, suffered wreck.

" 'The danger of the sailor is obviously greater, however, when he is overtaken by the storm on the inner side of storm-⊂. Here he has to encounter the double force of the cyclonic whirl and of the advancing storm-system, instead of the difference of the two motions, as on the outer side of the storm-track. His chance of escape will depend on his distance from the central path of the cyclone. If near to this, it is equally dangerous for him to attempt to scud to the safer side of the track, or to beat against the wind by the shorter course, which would lead him out of the storm on its inner side. It has been shown by Col. Sir W. Reid that this is the quarter in which vessels have been most frequently lost.

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* A ship, by scudding before the gale, may, if the captain is not familiar with the laws of cyclones, *go round and round* without escaping. The ship "Charles Heddle" did this in the East Indies, going round no less than *five times.*

"'But even the danger of this most dangerous quarter admits of degrees. It is greatest where the storm is sweeping round the most curved part of its track, which happens in about latitude twenty-five or thirty degrees. In this case, a ship may pass twice through the vortex of the storm. Here hurricanes have worked their most destructive effect. And thus it happens that sailors dread, most of all, the part of the Atlantic near Florida and the Bahamas, and the region of the Indian Ocean which lies south of Bourbon and Mauritius.'

"As to the origin of cyclones, it is believed they are caused by the great currents that traverse the ocean. In every cyclone region there is a strongly marked current, and each current follows closely the horse-shoe track above referred to. In the North Atlantic is the great Gulf Stream; in the South Indian Ocean the south equatorial current, which sweeps past Mauritius and Bourbon, and thence returns to the east; in the North China seas, there is the north equatorial current, which sweeps round the East Indian Archipelago and then merges into the Japanese current; and the current in the Bay of Bengal flowing through the region where cyclones are commonly met. There are other sea currents which breed no cyclones. Those named all flow from equatorial to temperate regions, and are all "horse shoe currents." These currents, carrying the warmth of intertropical climates to the temperate zones, produce important atmospheric disturbances. The vapor which rises from these currents of warm water is condensed as it rises by the colder air around, and the transformation of this vapor into water sets free an equivalent quantity of heat. The amount of heat thus set free over the Gulf Stream is thousands of times greater than that which would be generated by the whole coal supply annually raised in Great Britain. This is the explanation of hurricanes. Along the whole of the Gulf Stream there is a channel of heated, that is, rarified air. Into this channel the dense atmosphere on both sides is constantly pouring, and when a storm begins in the Atlantic it always makes for this channel, and reaching it, turns and follows it in its course, sometimes entirely across the Atlantic. The same is the case with the other heated ocean currents."

And, in conclusion, I again would call the attention of commanders to the importance of becoming familiar with this most important branch of navigation.

AN ACT

FIXING CERTAIN RULES AND REGULATIONS FOR PREVENTING COLLISIONS ON THE WATER.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That from and after September one, eighteen hundred and sixty-four, the following rules and regulations for preventing collisions on the water be adopted in the navy and the mercantile marine of the United States: *Provided*, That the exhibition of any light on board of a vessel of war of the United States may be suspended, whenever, in the opinion of the Secretary of the Navy, the commander-in-chief of a squadron, or the commander of a vessel acting singly, the special character of the service may require it.

PRELIMINARY NOTICE.

Every steamship which is under sail, and not under steam, is to be considered a sailing ship; and every steamship which is under steam, whether under sail or not, is to be considered a ship under steam.

RULES CONCERNING LIGHTS.

QUESTION 1.—When shall Lights be carried?

ANSWER.—In all weathers, between sunset and sunrise.

QUESTION 2.—Name the Lights for Steamships?

ANSWER.—Steam vessels, when under way, shall carry at the foremast head, a bright white light, so fixed as to show an uniform and unbroken light over an arc of the horizon of twenty points of the compass, so fixed as to throw the light ten points on each side of the ship, viz.: from right ahead to two points abaft the beam on either side, and of such a character as to be visible on a dark night, with a clear atmosphere, at a distance of at least five miles.

QUESTION 3.—On which side is the Green Light?

ANSWER.—On the starboard side, so constructed as to throw an uniform and unbroken light over an arc of the horizon of ten points of the compass, so fixed as to throw the light from right ahead to two points abaft the beam on the starboard side, and of such a character as to be visible on a dark night, with a clear atmosphere, at a distance of at least two miles.

Question 4.—On which side a Red Light?

Answer.—On the port side, so constructed as to show an uniform unbroken light over an arc of the horizon of ten points of the compass, so fixed as to throw the light from right ahead to two points abaft the beam on the port side, and of such a character as to be visible on a dark night, with a clear atmosphere, at a distance of at least two miles.

Question 5.—How shall said Lights be fixed?

Answer.—The said green and red side lights shall be so fitted with inboard screens, projecting at least three feet forward from the light, so as to prevent these lights from being seen across the bow.

Question 6.—Name the Lights for Steam Tugs?

Answer.—Steamships, when towing other ships, shall carry two bright white masthead lights vertically, in addition to their side lights, so as to distinguish them from other steamships. Each of these masthead lights shall be of the same construction and character as the masthead lights which other steamships are required to carry.

Question 7.—Name the Lights for Sailing Ships?

Answer.—Sailing ships, under way or being towed, shall carry the same lights as steamships under way, with the exception of the white masthead lights, which they shall never carry.

Question 8.—Name the exceptional Lights for Small Sailing Vessels, and how Painted?

Answer.—Whenever, as in the case of small vessels during bad weather, the green and red lights cannot be fixed, these lights shall be kept on deck, on their respective sides of the vessel, ready for instant exhibition; and shall, on the approach of or to other vessels, be exhibited on their respective sides in sufficient time to prevent collision, in such manner as to make them most visible, and so that the green light shall not be seen on the port side, nor the red light on the starboard side.

To make the use of these portable lights more certain and easy, they shall each be painted outside with the color of the light they respectively contain, and shall be provided with suitable screens.

Question 9.—Name the Lights for Ships at Anchor?

Answer.—Ships, whether steamships or sailing ships, when at anchor in road-steads or fair-ways, shall, between sunset and sunrise, exhibit, where it can best be seen, but at a height not exceeding twenty feet above the hull, a white light, in a globular lantern of eight inches in diameter, and so constructed as to show a clear, uniform and unbroken light visible all around the horizon, at a distance of at least one mile.

Question 10.—Name the Lights for Pilot Vessels?

Answer.—Sailing pilot vessels shall not carry the lights required for other sailing vessels, but shall carry a white light at the masthead, visible all round the horizon, and shall also exhibit a flare-up light every fifteen minutes.

Question 11.—Name the Lights for Fishing Vessels and Boats?

Answer.—Open fishing boats and other open boats shall not be required to carry side lights required of other vessels; but shall, if they do not carry such lights, carry a lantern having a green slide on the one side and a red slide on the other side, and on the approach of or to other vessels, such lantern shall be exhibited in sufficient time to prevent collision, so that the green light shall not be seen on the port side, nor the red light on the starboard side. Fishing vessels and open boats when at anchor, or attached to their nets and stationary, shall exhibit a bright white light. Fishing vessels and open boats shall, however, not be prevented from using a flare-up in addition, if considered expedient.

FOG-SIGNALS.

Question 12.—Give the Rules for Fog-Signals?

Answer.—Whenever there is a fog, whether by day or night, the fog signals described below shall be carried and used, and shall be sounded at least every five minutes.

Question 13—For Signal for Steamships?

Answer.—Steamships under way shall use a steam-whistle placed before the funnel, not less than eight feet from the deck.

Question 14.—Fog-Signals for Sailing Ships?

Answer.—Sailing ships under way shall use a fog-horn.

Question 15.—When not under way?

Answer.—Steamships and sailing ships, when not under way, shall use a bell.

RULES OF THE ROAD.

Question 16.—Give the Rule for Two Sailing Ships Meeting?

Answer.—If two sailing ships are meeting end on, or nearly end on, so as to involve risk of collision, the helms of both shall be put to port, so that each may pass on the port side of the other.

Question 17.—Rule for Two Sailing Ships Crossing?

Answer.—When two sailing ships are crossing so as to involve risk of collision, then, if they have the wind on different sides, the ship with the wind on the port side shall keep out of the way of the ship with the wind on the starboard side, except in the case in which the ship with the wind on the port side is close-hauled, and the other ship free, in which case the latter ship shall keep out of the way. But if they have the wind on the same side, or if one of them have the wind aft, the ship which is to windward shall keep out of the way of the ship which is to leeward.

Question 18.—Rule for Two Ships under Steam Meeting?

Answer.—If two ships under steam are meeting end on, or nearly end on, so as to involve risk of collision, the helms of both shall be put to port, so that each may pass on the port side of the other.

Question 19.—Rule for Two Ships under Steam Crossing?

Answer.—If two ships under steam are crossing so as to involve risk of collision, the ship which has the other on her own starboard side shall keep out of the way of the other.

Question 20.—Rule for Sailing Ship and Ship under Steam?

Answer.—If two ships, one of which is a sailing ship and the other a steamship, are proceeding in such directions as to involve risk of collision, the steamship shall keep out of the way of the sailing ship.

Question 21.—Rule for Ships under Steam to Slacken Speed?

Answer.—Every Steamship, when approaching another ship so as to involve risk of collision, shall slacken her speed, or, if necessary, stop and reverse; and every steamship shall, when in a fog, go at a moderate speed.

Question 22.—Rule for Vessels overtaking other Vessels?

Answer.—Every vessel overtaking any other vessel, shall keep out of the way of the said last-mentioned vessel.

Question 23.—When one Ship keeps out of the way, what does the other do?

Answer.—Keeps on her course.

PROVISO TO SAVE SPECIAL CASES.

In obeying and construing these rules, due regard must be had to all dangers of navigation, and due regard must also be had to any special circumstances which may exist in any particular case rendering a departure from the above rules necessary, in order to avoid immediate danger.

NO SHIP, UNDER ANY CIRCUMSTANCES, TO NEGLECT PROPER PRECAUTIONS.

Nothing in these rules shall exonerate any ship, or the owner, or master, or crew thereof, from the consequences of any neglect to carry lights or signals, or of any neglect to keep a proper look-out, or of the neglect of any precaution which may be required by the ordinary practice of seamen, or by the special circumstances of the case.

STOWAGE OF MIXED CARGOES.

1. Owners, commanders, and mates of ships are considered in law in the same situation as common carriers. It is therefore necessary that all due precautions be taken to receive and stow cargoes in good order, and deliver the same

in like good order. The law holds the ship-owner liable for the safe custody of the goods, when properly and legally received on board in good order, and for the "delivery," to parties producing the bill of lading. The captain's blank bill of lading should be receipted by the warehouse keeper, or person authorized to receive the contents. Goods are not unfrequently sent alongside in a damaged state, and letters of indemnity given to the captain by the shippers for signing in good order and condition. This is nothing more or less than conniving at fraud. Fine goods are also often damaged in the ship's hold by lumpers, if permitted to use cotton-hooks in handling bales. All goods must be received on board according to the custom of the port where the cargo is to be taken in; and the same custom will regulate the commencement of the responsibility of the master and owners.

2. HEMP, FLAX, WOOL, and COTTON, should be dunnaged 9 inches on the floors, and to the *upper part* of the bilge; the wing bales of the second tier kept 6 inches off the side at the lower corner, and 2½ inches at the sides. Sand or damp gravel ballast to be covered with boards. Pumps to be frequently sounded and attended to. *Sharp-bottomed ships one third more dunnage in floor and bilges.* Avoid Horn Shavings as dunnage from Calcutta.

3. All CORN, WHEAT, RICE, PEAS, BEANS, &c., when in bulk, to be stowed on a good high platform, or dunnage wood, of not less than 10 inches, and in the bilge 15 inches dunnage; the pumps and masts cased, to have strong bulkheads, good shifting boards, with feeders and ventilators, and to have no admixture of other goods. Flat-floored, wall-sided ships should be fitted with bilge pumps. On no consideration must the stanchions under the beams be removed.

4. OIL, WINE, SPIRITS, BEER, MOLASSES, TAR, &c., to be stowed bung up; to have good *cross-beds* at the quarters, (*and not to trust to hanging beds*), to be well chocked with wood, and allowed to stow three heights of pipes or butts, four heights of puncheons, and six heights of hogsheads or half-puncheons. All Moist Goods and Liquids, such as SALTED HIDES, Bales of BACON, BUTTER, LARD, GREASE,

CASTOR OIL, &c., shall not be stowed too near "Dry Goods," whose nature is to absorb moisture. Ship owners have often to pay heavy damages for leakage in casks of molasses, arising from stowing too many heights without an intervening platform or 'twixt decks. From Bengal, goods also are frequently damaged by Castor Oil.

5. TEA and FLOUR, in barrels; FLAX, CLOVER, and LINSEED or RICE, in tierces; COFFEE and COCOA, in bags, should always have 9 inches, at least, of good dunnage in the bottom, and 14 to the upper part of the bilges, with 2½ inches at the sides; allowed to stow six heights of tierces, and eight heights of barrels. All ships above 600 hundred tons should have 'twixt decks or platforms laid for these cargoes, to ease the pressure; caulked 'twixt decks should have scuppers in the sides, and 2½ inches of dunnage laid athwart ship, and not fore-and-aft ways, when in bags or sacks; and when in boxes or casks not less than 1 inch. RICE, from Calcutta, is not unfrequently damaged by Indigo, for want of care in stowage.

6. Entire cargoes of SUGAR, SALTPETRE, and GUANO, in bags, must have the dunnage carefully attended to, as laid down for other goods. TIMBER ships are better without 'twixt decks if loading all Timber or Deals. Brown Sugar to be kept separate from White Sugar, and both kept from direct contact with Saltpetre.

7. Pot and Pearl ASHES, TOBACCO, BARK, INDIGO, MADDER, GUM, &c., whether in casks, cases or bales, to be dunnaged in the bottom, and to the upper part of the bilges, at *least* 9 inches, and 2½ inches at the sides.

8. MISCELLANEOUS GOODS, such as boxes of CHEESE, kegs and tubs of LARD, or other small or slight made packages, not intended for broken stowage, should be stowed by themselves, and dunnaged as other goods.

9. BARRELS of PROVISIONS and TALLOW casks allowed to stow six heights. All METALS should be stowed under, and separated from, goods liable to be damaged by contact.

10. All MANUFACTURED GOODS, also DRY HIDES, bales of SILK, or other valuable articles, should have 2½ inches of

dunnage against the side, to preserve a water course. Bundles of Sheet Iron, Rods, Pigs of Copper or Iron, or any rough hard substance, should not be allowed to come in contact with bales or bags, or any soft packages liable to be chafed. When mats can be procured, they should be used at the sides for Silk, Tea, &c.

11. Tar, Turpentine, Rosin, &c., to have flat beds of wood under the quarters, of an inch thick, and allowed to stow six heights.

12. Very frequent and serious loss falls on Merchants on the upper part of cargoes, particularly in vessels that bring Wheat, Corn, Tobacco, Oil Cake, &c., arising from vapor-damage imbibed by Wheat, Flour, or other goods, stowed in the same vessel with Turpentine, or other strong-scented articles. The shippers are to blame for such negligence, for not making due inquiry before shipping.

13. Ships laden with full cargoes of Coal, bound round Cape Horn or Cape of Good Hope, to be provided with approved ventilators, as a preventive against ignition.

14. No vessel bound on any over-sea voyage, should on any account be loaded beyond that point of immersion which will present a clear side out of water, when upright, of three inches to every foot depth of hold, measured amidships, from height of the deck at the side, to the water.

Note.—Shippers abroad, when they know that their cargoes will be stowed properly, will give a preference and at higher rates, to such commanders of ships as will undertake to guarantee the dunnage. The American ship owners, in the stowage of mixed cargoes in large ships, have, from experience, discovered what "pressure" flour barrels, provision casks, &c., will bear, and so avoid reclamations for damage, if otherwise properly stowed. Hence, in large ships above 600 tons, with dimensions exceeding in length 4½ times the beam, and 21 feet depth of hold, orlop decks will come into general use, so as to relieve the pressure, by dividing a ship's hold, like a warehouse in stories.

Ship's cargoes, for Insurance, will also become a matter of special agreement between merchant and ship owner, and merchant underwriters, and the premium vary according to the dunnage agreement. The stowage and dunnage must stand A 1, and is often of more importance than the class of the vessel, as experience has proved. When ships are chartered for a lump sum the draft of water should be limited, as it not unfrequently happens that brokers insert a clause that coals are not to be considered as dead weight, in order to fill the ship up in case of goods falling short to make up the chartered freight. All packages bales, and cases, not weighing more than 25 cwt. to the cubic ton measurement, are designated light freight.

Bale Goods should be stowed on their *flats* in midships, on their *edges* in the wings. In a general cargo, the Dry Goods should be stowed in the after-part of the ship.

Bar Iron should be stowed diagonally (or grating-fashion), bringing it up like a pyramid FROM THE ENDS. Stowed in this way, it is not such a dead weight in the ship.

LOCAL ATTRACTION

Is a term used to denote the influence of Iron in disturbing the direction of the Magnetic Needle. It is therefore necessary that Masters should be able to ascertain, as well as know, how to apply the errors arising from local magnetic disturbance.

To do this, determine the true bearing of a conveniently distant object. Let the ship be carefully swung to each point of the compass, and on each occasion let the bearing of the object be taken. The difference between the true and observed bearing will be the error of the compass, and will be named *East* when the north point of the needle is drawn to the eastward, or right hand; *West*, when it is drawn to the westward, or left hand; and must be applied to the ship's courses in the same manner as variation of the compass.

BAROMETER.

For measuring the weight of the atmosphere, the Barometer has long been esteemed one of the most valuable scientific instruments. In meteorological observations it is the essential instrument of scientific research; for registering the changes of the weather it affords valuable aid, and to the seaman it is indispensable. It was invented in 1643, by Torricelli, the pupil of Galileo, who, in investigating the cause of water ascending in pumps to the height of 32 feet, and no higher, made the following experiment.

He took a glass tube about four feet long, sealed at one end and open at the other, and having filled it with mercury, closed the open end with his finger; he then inverted the tube, and placed the open end under the surface of a small quantity of mercury in a basin, and, raising the tube perpendicular, withdrew his finger: he observed the mercury in the tube suspended to the height of 27½ inches above the surface of that in the basin. He compared the height of the column of mercury with the height of a column of water raised by the pump, and perceiving those heights to be in an inverse ratio of the specific gravities of the water and mercury, he concluded they were kept in suspension by a common cause. A further consideration of the experiment led him to remark that the upper extremities of the columns of water and mercury had no communication with the atmosphere, but that the lower extremities had a communication, and he attributed the elevation of the columns in the tubes to the weight of the atmosphere.

In 1646 Pascal, at Rouen, repeated Torricelli's experiments with similar results. He also varied them by employing liquids of different specific gravities, and he perceived that the lighter the liquid the higher it ascended to the tube; but the agency of an invisible fluid was still doubted, and he therefore determined to make an experiment on the top of the mountain Puy de Dome, near Clermont, in Auvergne, which should silence controversy. Two tubes filled with mercury, the columns of equal heights, were carried to the foot of the mountain, one of which was left there standing at 28 inches, and the other taken to the summit; as they ascended, the mercury in the tube gradually sunk until it stood at 24.7 inches; as they descended, the mercury as gradually rose again; and when placed by the side of the tube left below, their elevations coincided. As Pascal had anticipated, in ascending the mountain the weight of a portion of the column of the atmosphere, equal to the height of the mountain, being removed from the surface of the mercury in the basin, that which was in the tube fell, until its weight was again counterpoised by the atmosphere; and conversely in descending the weight of the column of the atmosphere being increased by the weight of the portion equal to the height of the mountain, pressed upon the mercury in the basin, and forced it to ascend in the tube until both weights balanced each other.

Pascal originated the idea of measuring elevations by the variations of the barometer; but he foresaw a difficulty. He compared the atmosphere to a mass of wool, the lowest parts of which were more pressed than those above; and his sagacity led him to the fact that from the dilatation of the atmosphere, the rise and fall of the mercurial column would not be equal through equal spaces. This concluded his philoshopical inquiries; he afterwards turned his attention to theology.

In 1666 Boyle discovered that the atmosphere was elastic and compressible; and about the same period Mariotte proved its density was in proportion to the weight with which it was compressed. The stratum of the atmosphere nearest the surface of the earth supports the weight of all above it, and is the densest; each stratum as we ascend becomes lighter or more rare, because its elasticity is less checked by having a less weight pressing from above. Pere Cotte deduced that the ratio of the decrease of its density was in geometrical progression. Thus, if the density at one mile high was 1, and that at four miles high $\frac{1}{2}$, then that at seven miles high would be $\frac{1}{4}$, at ten miles high $\frac{1}{8}$, at thirteen miles high $\frac{1}{16}$, &c.; but this ratio is much disturbed by changes in the temperature of the strata of the atmosphere at different elevations. Heat expands the bulk of air, and forces it to occupy a larger space; 1000 volumes of air at 32° of Fahrenheit become expanded into 1057-34 volumes at 60°: thus heat is a cause of the unequal rise and fall of the barometer through equal spaces. Sir George Shuckburgh made numerous experiments upon the effects of temperature on the atmosphere; and from his labors we have a table, which shows in feet how much the spaces passed through may vary from temperature in a fall of $\frac{1}{10}$ of an inch of mercury, the barometer standing at 30 inches; and by means of his theorem for its application, we are now enabled to ascertain the heights of mountains by the barometer as correctly as by geometrical measurement.

RULES FOR THE BAROMETER.

A RISING BAROMETER.

A "Rapid" rise indicates unsettled weather.

A "Gradual" rise indicates settled weather.

A "Rise" with dry air and cold increasing, in summer, indicates wind from the northward, and, if rain has fallen, better weather.

A "Rise," with moist air and low temperature, indicates wind and rain from the northward.

A "Rise," with a south wind, indicates fine weather.

A STEADY BAROMETER

With dry air and a seasonable temperature, indicates a continuance of fine weather.

A FALLING BAROMETER.

A "Rapid" fall indicates stormy weather from the northward (if the wind is westerly).

A "Fall," with a northerly wind, indicates a storm, with *rain* in summer, and *snow* in winter.

A "Fall," with increased moisture in the air, and the heat increasing, indicates wind and rain from the southward.

It is not so much the hight of the mercury, as its motion up and down, that indicates the weather. The mercury sometimes is sluggish, and sticks to the side of the glass; therefore, when you take an observation by it, always shake the tube lightly first, and if the air be growing heavier, the mercury will rise; and, if growing lighter, it will sink.

The quicksilver in the tube is kept up by the pressure of the atmosphere, and when the air is dense and heavy it supports the clouds and vapors, and when it is rare and thin it is unable to support them, and they fall in the form of *mist*, *rain* or *snow*. Therefore, when the quicksilver rises, it is a sign of fair weather, and when it falls, of foul weather.

WEATHER SIGNS.

A few of the most marked signs of weather, useful to the seaman, are the following:

Whether clear or cloudy, a rosy sky at sunset presages fine weather; a red sky in the morning, bad weather, or much wind (perhaps rain); a gray sky in the morning, fine weather; a high dawn, wind; a low dawn, fair weather.

Soft-looking or delicate clouds foretell fine weather, with moderate and light breezes; hard-edged, oily-looking clouds, wind. A dark, gloomy, blue sky is windy; but a light, bright, blue sky indicates fine weather. Generally, the *softer* clouds look, the less wind (but perhaps more rain) may be expected; and the harder, more "greasy," rolled, tufted, or ragged, the stronger the coming wind will prove. Also a bright yellow sky at sunset presages wind; a pale yellow, wet; and thus, by the prevalence of red, yellow, or greasy tints, the coming weather may be foretold very nearly; indeed, if aided by instrument, almost exactly.

Small inky-looking clouds foretell rain; light scud clouds driving across heavy masses show wind and rain; but if alone, may indicate wind only.

High upper clouds crossing the sun, moon, or stars in a direction different from that of the lower clouds, or the wind then felt below, foretell a change of wind.

After fine, clear weather, the first signs in the sky of a coming change are usually light streaks, curls, wisps, or mottled patches of white distant clouds, which increase, and are followed by an overcasting of murky vapor that grows into cloudiness. This appearance, more or less oily or watery, as wind or rain will prevail, is an infallible sign.

Usually, the higher and more distant such clouds seem to be, the more gradual, but general, the coming change of weather will prove.

Light, delicate, quiet tints or colors, with soft, undefined forms of clouds, indicate and accompany fine weather; but gaudy or unusual hues, with hard, definitely-outlined clouds, foretell rain, and probably strong wind. Misty clouds forming, or hanging on hights, show wind and rain coming, if they remain, increase, or descend. If they rise or disperse, the weather will improve or become fine.

When sea-birds fly out early, and far to seaward, moderate wind and fair weather may be expected.

When they hang about the land, or over it, sometimes flying inland, expect a strong wind, with stormy weather.

Dew is an indication of fine weather; so is fog. Neither of these two formations occur under an overcast sky, or when there is much wind. One sees fog occasionally rolled away, as it were, by wind; but seldom or never *formed* while it is blowing.

Remarkable clearness of atmosphere near the horizon; distant objects, such as hills, unusually visible, or raised (by refraction); and what is called "a good *hearing* day," may be mentioned among signs of wet, if not wind, to be expected.

MISCELLANEOUS QUESTIONS IN NAVIGATION.

Question.—What do you understand by Declination?

Answer.—Declination of the sun, moon, or star, is their distance from the Equinoctial, northward or southward; and the greatest declination the sun can have is 23° 28′ North or South.

Q.—What do you understand by an Altitude?

A.—It is the hight of the sun, moon, or stars above the horizon, reckoned in degrees, minutes, and seconds.

Q.—What is an Amplitude?

A.—An arch of the horizon, contained between the East and West points of the heavens, or the centre of the sun or star at its rising or setting.

Q.—What is an Angle?

A.—Two lines meeting in a point.

Q.—What do you understand by an Axis?

A.—It is an imaginary line passing through the earth's centre.

Q.—What is an Azimuth?

A.—Azimuths are great circles which pass through the Zenith and Nadir, and are perpendicular to the horizon.

Q.—What is an Artificial Day?

A.—It is the time between the sun rising and sun setting.

Q.—What is the Astronomical Day?

A.—It is the time between two successive transits of the sun's centre, over the same meridian which always begins and ends at noon.

Q.—What is a Sea Day?

A.—It is the time from the noon of one day to the noon of another day.

Q.—How do these days differ from each other?

A.—The noon of the civil day, and the ending of the sea day, and the commencement of the astronomical day, all take place at the same time.

Q.—What do you understand by Equation of Time?

A.—It is the difference between true clock and sun time.

Q.—What is the Equator?

A.—It is a great circle, which divides the Northern from the Southern Hemisphere, and being referred to the heavens, is called the Equinoctial.

Q.—What do you understand by the Latitude of a star or planet?

A.—It is its distance from the ecliptic.

Q.—What is the Ecliptic?

A.—It is a great circle of the sphere, in which the sun always appears to move; the angle it makes with the equator is always about 23° 28′.

Q.—What is the Longitude of a Star or Planet?

A.—It is its distance from the first point of Aries, reckoned in degrees and minutes.

Q.—What is Latitude of a place?

A.—It is its distance North or South of the Equator.

Q.—What is Longitude of a place?

A.—It is its distance from the East or West of Greenwich.

Q.—What are Lunar Months?

A.—The time between one new moon and another, which is about 29 days, 12 hours, 44 minutes.

Q.—What is Meridian?

A.—It is a great circle, which passes through the Zenith and Poles, and is perpendicular to the horizon; when the sun is upon this circle it is mid-day or noon.

Q.—What is Parallax?

A.—It is the difference between any celestial object, as seen from the surface of the earth and from its centre.

Q.—What is Refraction?

A.—Refraction of any body is the quantity which that body appears above its true place in the heavens, as it makes all heavenly bodies appear higher than they are.

Q.—What is Semi-Diameter?

A.—It is a correction necessarily applied to the sun, moon, or planet's altitude, in order to reduce the altitudes to the centre of the body.

Q.—What is Right Ascension?

A.—It is that degree of the equator, which comes to the meridian with the sun, moon, or star, reckoned from the first point of Aries.

Q.—What do you understand by Polar Distance?

A.—It is the distance of the object from the elevated Pole, from the North in North Latitude and the South in South Latitude.

Q.—What are Diurnal Motions?

A.—They are daily motions.

Q.—What is an Horizon?

A.—It is a great circle of the earth, 90° from the zenith, and is called the rational horizon. The sensible horizon is the circle that bounds our sight. A horizon at sea would be called a sensible horizon.

Q.—What is a Quadrant?

A.—It is the fourth part of a circle.

Q.—What is a Radius?

A.—A line from the centre of the Circle to the circumference.

Q.—What is the Dip of the Horizon?

A.—It is caused by the eye of the observer being elevated above the horizon at his feet.

Q.—Describe the North Star, and how you find it?

A.—The North Star is a *binary* or *double star*. It is composed of two stars of very unequal magnitude. The largest is white, and the smallest is red; and to the naked eye they appear single. To find this star: In the great Bear there are seven bright stars; two stars in a body, most distant from the tail, are called the pointers, as they point directly to the North Star, which is distant 29° from them.

Q.—How do you distinguish a Planet from a Fixed Star?

A.—Planets are easily distinguished from a fixed star by their steady light. They never twinkle, except when near the horizon. And fixed stars may be distinguished from planets by the twinkling of their light.

Q.—What is Sidereal Time?

A.—Time belonging to the stars or planets.

Q.—What is Apparent Time?

A.—It is sun time.

Q.—What is Mean Time?

A.—It is clock time, or true time.

MISCELLANEOUS QUESTIONS IN SEAMANSHIP.

Q.—How do you mark a Log Line?

A—As 6,000 feet is one sea mile, the sixtieth part of this is 100 feet; and one minute being the sixtieth part of an hour, if the log line was marked for 100 feet for a knot, the log glass would have to be one minute long, because, if the ship goes one hundred feet in one minute, she would go 6,000 feet in an hour. Therefore, the best way is to mark the log line 48 feet to the knot, and use a 28″ glass.

Q.—How do you mark a Lead Line?

A.—A lead line has nine *marks* and eleven *deeps*.

At 2 fathoms the mark is Leather.
At 3 “ “ “ Leather.
At 5 “ “ “ White Rag.
At 7 “ “ “ Red Rag.
At 10 “ “ “ Leather, with hole.
At 13 “ “ “ Blue Rag.

At 15 fathoms the mark is White Rag.
At 17 " " " Red Rag,
At 20 " " " Cord, with two knots.

Q.—How do you mark a Deep Sea Line?

A.—It is marked in a similar manner to the 20 fathom line, after which a piece of cord, with an additional knot to every 10 fathoms, is fixed to the line, and between the tens a piece of leather, to denote five fathoms.

Q.—What is the general Rule for Ship's Anchors?

A.—500 pounds to every 100 tons of ship's measurement; but a ship over 500 tons does not require so large a proportion.

Q.—What per centage will a full built ship carry above her tonage?

A.—About fifty per cent. Thus, a ship of 300 tons ought to carry 450 tons measurement goods, calculating 40 cubic or solid feet to the ton.

Q.—How much will a 500 ton sharp-built carry?

A.—About 75 per cent. above her tonage.

Q.—How much will a 1,000 sharp-built carry?

A.—About 60 per cent. of her tonage.

OBTAINING HIGHTS AND DISTANCES.

Table Tenth of Bowditch's Navigator contains the distances at which any object is visible at sea.

The solution of Problems worked by it depends on the uniform curviture of the sea, by means of which all terrestrial objects disappear at certain distances from the observer.

Distances may be computed by table 10th, by finding the hight of the eye of the observer in feet above the water, in one column, opposite which is the distance in another column, also the hight of the object in the same column as hight of eye, and opposite it the corresponding distance in the other column; these two distances are then added together, and we have the distance of the object in statute miles. Hence the Rule.

If the place from which you view the object be elevated above the horizon, add together the distance corresponding to the hight of the eye, and the distance corresponding to the hight of the observed object, and their sum is the distance required.

EXAMPLE 1ST.

Running in for Cape Cod from the Eastward, I see a light just appearing in the horizon, my eye being elevated 20 feet above the surface of the sea. Required the distance the ship is off the light.

In this example the hight of the observer was 20 feet and the hight of the object 200 feet:

In table 10th, opposite 20 feet, is 5′.92
" " " " 200 " " 10′.71
24′.63 Statute miles,

or 29 Nautical miles.

EXAMPLE 2D.

Being on the main topgallant mast head of my ship, 200 feet above the water, I see a ship I spoke the day before, hull to. Required the distance she is off.

In this example the ship is supposed to be 40 feet from the quarter deck to the water:

In table 10th, opposite 40 feet, is 8′.37
" " " " 200 " " 18′.71
27′.08 Statute miles

the ship is off, or 31 Nautical miles, a Nautical mile being $\frac{1}{6}$ more than a Statute mile.

FOR MEASURING HIGHTS.

To obtain the hight of any object by one altitude, measure off any number of feet from the base of the object, and from that station observe the altitude with a quadrant or sextant.

The number of feet measured off will be the base of the triangle. The object forms the tangent of the observed angle. Therefore proceed as per the following statement:

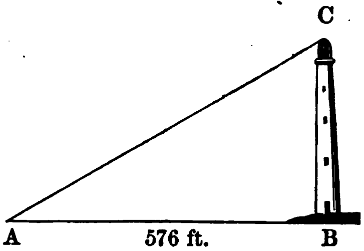
Radius 10.00000 is to base, as the tangent of the observed angle of altitude is to the required hight.

EXAMPLE 1st.

Being 576 feet from the bottom of a Tower, I found its altitude above the horizon, drawn from my eye, to be 15°.10′.

Required the height of the Tower.

Draw the line A B equal 576 ft.; then perpendicular thereto the line B C; draw the angle B A C equal to 15° 10′; then draw the line A C to cut B C at C, and B C, the tangent of B A C, will be the height of Tower.



BY LOGARITHMS.

As the Radius 90° = 10.00000
Is to the distance A B 576 feet Log. = 2.76042
So is the Tangent angle A 15° 10′ = 9.43308

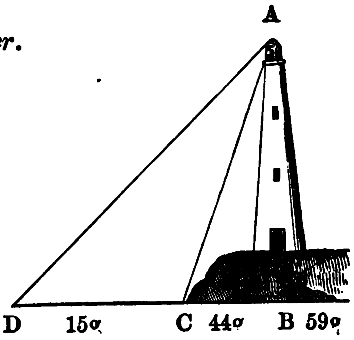
To the height B C 156.1 feet = 2.19350

When the height of any monument, mast, or lighthouse is to be determined, measure the angular elevation of the object with a sextant at the base first; then measure off directly from the first station any number of feet, and observe another altitude at that station, and proceed as in the following

EXAMPLE.—I observed the altitude of the top of a tower above the level of the sea to be by my sextant 59°; then measuring off directly from the first station 294 feet, its elevation was found to be 44°.

Required the height of the Tower.

Let A B be the height of Tower at C first station; this will give you the angle A C B equal to 59°, and the angle A D B equal to 44°, and the angle D A C = 59° — 44 = 15°.



To find side A C.

As D A C 15° = Sine	9.41300—
Is to D C 294 ft. = Log.	2.46835
So is A D C 44° — Sine	9.84177
	12.31012—
	9.41300—
To A C 789.1 feet=	2.89712

To find the hight.

As Radius =	10.00000
Is to A C 789 = Log. =	2.98708
So is A C B 59° = Sine	9.93307
To A B C 676.3 feet = Hight of Tower.	2.83015

THE VELOCITY OF SOUND.

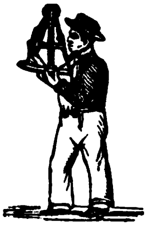
To obtain the distance off from a gun by noting the time between the *flash* and the *report.*

It has been found by observation that Sound moves at the rate of 1,142 feet per second, or about one statute mile in 4″6. Therefore, the number of seconds elapsed between seeing the flash and hearing the report being divided by 4″6, will give the distance off from the gun in statute miles.

Example.—Upon seeing the flash of a gun to the leeward, I counted 35″ by my watch before I heard the report. Required the distance that gun was fired from me, supposing the sound moved at the rate of 1,142 feet per second:

Time elapsed, 35″0
4″6)32 2(7½ Statute miles, or
28 8¾ Nautical miles nearly.

Note.—The velocity of sound at 32° Fahrenheit is 1,090 feet per second, and for each additional degree of heat add 0.96 of a foot to this velocity. For example, for 33° = 1090.96 feet, for 34° = 1091.92 feet, for 35° = 1092.88, and so on in the same proportion.



ADJUSTMENT OF THE SEXTANT.

FIRST.—*The Index Glass should be perpendicular to the plane of the Instrument.*

To determine this, put 0 on the vernier to 50° on the arc, and hold the instrument parallel. Look into the Index glass and see if the true and reflected arc appear exactly in a line. If so, the Index glass is perpendicular to the plane of the instrument; if not, the error must be rectified by the screws back of the glass.

SECOND.—*The Horizon Glass should be perpendicular to the plane of the Instrument.*

To ascertain this, put 0 on the vernier to 0 on the arc. Hold the instrument in a vertical position, and look at the horizon through the telescope. If the true and reflected horizon form one continuous line, the horizon glass is adjusted, and stands parallel to the Index glass; if not, the error must be rectified by the screws before and behind it.

THIRD....*To find the Index Error.*

Put 0 on the vernier to 0 on the arc, and look at the horizon or any other well defined object (distant over a mile), and if it forms a straight line in the horizon glass, there is no Index error; but if it does not form a straight line, you must make it do so by means of the tangent-screw, and then read off. Half the difference of the two readings will be the Index error; and if the reading is to the right of 0 on the vernier, the error is additive to all altitudes taken (because the altitude will be too little); if to the left, the error is subtractive from all altitudes taken (because the altitudes will be too much).

EXAMINATION FOR SECOND MATE.

QUESTIONS IN ADDITION, SUBTRACTION, MULTIPLICATION.

KEEPING A LOG.

DAY'S WORK.

H.	K.	F.	Courses.	Winds.	Lee way.	Remarks.
1						P. M. I take my departure from a point of land in Lat. 34 deg. 51 min. S. Long. 20 deg. 2 min. E. bearing by compass N. N. W. ½ W. distant 17 miles.
2	7	2	S.	N. by W.	0	
3	6	4				
4	7	0				
5	7	4				
6	7	0	S. by E.		0	
7	6	8				
8	7	2				
9	6	8	S. E.	N. E. by E,	¼	
10	6	8				
11	7	4				
12	7	0	East.	N. N. E.	½	
1	6	8				A. M.
2	7	2				
3	6	4				
4	5	6				A current set W. by S. by compass, at the rate of 2½ miles an hour.
5	6	0	E. N. E. ½ E.	North,	¼	
6	6	6				
7	6	4				
8	7	0	N. N. W.	N. E.	¾	
9	6	0				
10	6	6				
11	5	4				
12	6	0				Variation 2¼ points W.

ANSWERS....Diff. Lat. 54′.3 S. = Dept. 31′.4 E. Course S. 30° E. = dist. 63′ miles. Lat. in 35° 45′ S. = Long. 20° 41′ E. Diff. Long. 39′ E.

KEEPING A LOG.

DAY'S WORK.

H.	K.	F.	Courses.	Winds.	Lee way.	Remarks.
1						P. M. I take my departure
2	4	6	S. W.	N.W.by N.	0	from a point of land
3	5	4				in Lat. 40 deg. 29
4	6	0				min.N.Long. 124 deg
5	7	0	S. S. W.		0	32min.W.bearing by
6	6	6				compass E. ½ S. dis-
7	6	4				tant 17 miles.
8	6	6	W. S. W.		¼	
9	7	4				
10	8	0				
11	7	6	N. W.	N. N. E.	½	
12	7	4				
1	8	0				A. M.
2	7	6				
3	7	4				A current set E. N. E. by
4	7	4	W. N. W.		0	compass 14 miles,
5	6	6				during the last 10
6	6	4	S. E. by E.	N. E. by E.	½	hours.
7	6	4				
8	5	4				
9	5	4				
10	6	4				
11	7	0				
12	8	0			1	Variation 1¼ points E.

ANSWERS.—Diff. Lat. 19′ S. = Dept. 57′.5 W. Course S. 71⅔° W. dist. 61′.5 = Lat. in 40° 10′ N. Long. in 125° 47′ W. Diff. Long. 1° 15′ W.

KEEPING A LOG.

DAY'S WORK.

H.	K.	F.	Courses.	Winds.	Lee way.	Remarks.
1	7		S. W.	S. S. E.		Left the Cape in Lat. 25 min. N. Long. 33 min. W. bearing E. S. E. 18 min. by compass. A current at the rate of 3½ min. P. H. throughout, E. ½ N. by compass, Var. 4½ pts. W.
2	6					
3	6	5				
4	6	5				
5	5		S. S. W.	W.	½	
6	5					
7	5					
8	4					
9	4	6	N. E.	E. S. E.	1	
10	4					
11	3	4				
12	3					
1	2	5	N. b. W. ½ W.	N. E.	2	
2	2	5				
3	2					
4	2					
5	1		Up N. N. W.			Hove to under a close-reefed m. topsail.
6	1					
7	1				5	
8	1		Off N. W.			
9	2		S. W.	S. S. E.	2	
10	3					
11	4					
12	5					

Question 1.—Multiply 76 by 43, by Logarithms.
" 2. " 109 by 47, by "
" 3. " 3009 by 4, by "
" 4. " 144 by 4, by "
" 5. " 786 by 393, by "
" 6. " 1728 by 144, by "

Question 7.—Jan. 29, 1861, Long. 80° 30′ E. observed meridian altitudes of the sun was 59° 10′, bearing North. Index Error 1′ 2″+ Eye 18 feet. *Required the latitude of ship.*

Question 8.—Feb, 25, 1861, Long. 36° 15′ W. observed meridian altitude of the sun was 42° 59′, bearing South. Index Error 1′ 22″—Eye 20 feet. *Required the latitude of ship.*

Question 9.—March 20, 1861, Long. 145° 30′ E. observed meridian altitude of the sun was 67° 05′ 30″, bearing South. Eye 19 feet. Index Error 39″ add. *Required the latitude of ship.*

Question 10.—Ship left latitude 54° N., and she made 60 miles dept. *Required the different longitude by parallel sailing.*

Question 11.—Ship left latitude 50° S., and made 63 miles dept. *Required the different longitude by parallel sailing.*

Question 12.—Ship left latitude 40° N, and made 108 miles dept. *Required the different longitude by parallel sailing.*

Question 13.—August 13, 1861. In longitude 70° W. correct the declination for the place of the ship at noon.

Question 14.—Jan. 17, 1861. Required the true declination for the longitude of 105° W. at noon.

Question 15.—Jan. 17, 1861. Required the true declination for place of the ship, longitude 105° W. at 8h 30′ A. M.

Question 16.—Jan. 19, 1861. Required the true declination for place of ship, longitude 79° E. at noon; at 8h 45′ A. M., and at 4h 25′ P. M.

Question 17.—How do you adjust the Quadrant, and find the Index Error?

Question 18.—Observe an Altitude, and read it off?

SEAMANSHIP.

Question 1. Take in a Topgallant Sail, on the wind?
" 2. Take in a Topsail, on the wind?
" 3. Take in a Topsail, scudding?
" 4. Take in a Topsail, blowing heavy?
" 5. Take in a Jib, blowing heavy?
" 6. Reef a Main Topsail, on the wind?
" 7. Close Reef a Main Topsail, scudding?
" 8. Tack Ship, with Mainsail hauled up?
" 9. Tack Ship, against a heavy head sea?
" 10. Wear Ship, under Topsail and Foresail?
" 11. Wear Ship, under courses?
" 12. Wear, under bare poles?
" 13. Heave to, under close-reefed maintopsail, and storm staysail?
" 14. Man overboard. What do you do? Ship on the wind?
" 15. Man overboard. What do you do? Ship sailing free, with studding sails set?
" 16. Speak a vessel at sea, you being to the windward?
" 17. Speak a vessel at sea, you being to the leeward?
" 18. Get a sound by the deep-sea lead, running free?
" 19. Get a sound by the deep-sea lead, on the wind?
" 20. Come to an anchor, wind free?
" 21. Come to an anchor, on the wind in a tideway?

Question 22. Come to an anchor, and moor ship?
“ 23. Bend a Topsail?
“ 24. Bend a Course?
“ 25. Bend a Jib?
“ 26. Bend a Spanker?
“ 27. Bend a Topsail in a gale of wind?
“ 28. Unbend a Topsail and course?
“ 29. Unbend a Jib?
“ 30. Rig a pair Shears, to take in a lower mast?
“ 31. Take in a Lower Mast from long side, and step it?
“ 32. Take in a Bowsprit?
“ 33. Send up your Top, and get it over?
“ 34. Send up your Topmast and Cross-trees?
“ 35. Rig out a Jib-boom?
“ 36. Cross a Lower Yard?
“ 37. Send up a Topsail Yard, and Topgallant Yard?
“ 38. Rig a Lower Mast, Topmast, and Topgallant Mast?
“ 39. Put on your Backstays and Fore-and-Aft Stays?
“ 40. Rig your Fore and Foretopsail Yards?
“ 41. Mark a Log Line?
“ 42. Mark a Lead Line?

LIGHTS.

Question 1. When shall Lights be carried?
“ 2. Name Lights for steamers?
“ 3. On which side is the Green Light carried?
“ 4. On which side is the Red Light carried?
“ 5. Name Lights for Tug-Boats?
“ 6. Name Lights for Sailing Ships?
“ 7. Name Lights for Ships at anchor?

Question 8. Name Lights for Pilot Vessels?
" 9. Name Lights for Fishing Vessels and Boats?

FOG SIGNALS.

Question 1. Give the rule for using Fog Signals in vessels?
" 2. Give the rule for using them in steamships?
" 3. Give the rule for vessels not under way?
" 4. Give the rule for steamships not under way?

RULES OF THE ROAD.

Question 1. Give the rule for two sailing vessels meeting end on?
" 2. Give the rule for two sailing vessels crossing?
" 3. Give the rule for two steamships meeting end on?
" 4. Give the rule for two steamships crossing?
" 5. Give the rule for a sailing ship and steamer meeting?
" 6. Give the rule for a steamer approaching a ship, involving a risk of collision?
" 7. Give rule for a vessel overtaking another vessel?
" 8. When one ship keeps out of the way what does the other do?

FIRST MATE'S EXAMINATION.

IN ADDITION TO SECOND MATE'S EXAMINATION.

Question 1.—Aug. 26, 1867. In Latitude 31° 52′ N., longitude 69° 20′ W., by account. Altitude of sun's lower limb was 36° 38′ P. M., hight of eye 15 feet, time by chronometer 8h 2′ 45″, and chronometer slow of Greenwich time 7′ 50″. *Required the longitude of ship.*

Question 2.—March 9, 1866. Longitude by dead reckoning, 147° 18′ W., sun's altitude 38° 16′ A. M., time by watch, 8h A. M., time by chronometer, 18h 42′ 13″. After taking this sight the ship sailed S. S. W., *true*, eight miles per hour, and at noon the altitude of the sun was 73° 26′ bearing south. *Required the latitude and longitude at noon.*

Question 3.—October 18, 1861. In latitude 37° 15′ N., time per watch 8h 30′ A. M., sun's altitude was 22° 15′ 30″ A. M., time per chronometer 14h 05′ 13″ P. M. The error of the chronometer on the day the ship went to sea, May 15, 1861, was 5′ 13″.8 slow, and losing 1″.3, per day, up to Oct. 18, which was 157 days. Eye was 21 feet high. Index error 3′ + add. *Required the longitude of ship.*

Question 4.—Nov. 13, 1861. At 6h 30′ A. M., in latitude 25° 30′ N., longitude per log 68° 30′ W. The observed amplitude of the sun was found to be E. 28° 30′ N. *Required the variation of the compass.*

Question 5.—Feb. 14, 1861. At 5h 25′ P. M., in latitude 20° 05′ S., longitude 110° E. The observed amplitude of the sun was found to be W. 11° 15′ S. *Required the variation of the compass.*

Question 6.—Jan. 6, 1861. At 3h 47′ P. M., in latitude 37° 14′ South, longitude 142° 03′ West, the sun's altitude was found to be 39° 08′ 20″ P. M. The observed azimuth of the sun was S. 78° 45′ West. Index error 32″ add. Eye 19 feet high. *Required the variation of the compass.*

Question 7.—Oct. 20, 1861. At 8h A. M., in latitude 42° 22′ N., longitude 71° West, sun's altitude was found to be 21° 13′ N. The observed azimuth of the sun was N. 98° E. Eye was 19 feet high. Index error, 3′ + add. *Required the variation of the compass.*

Question. 8.—Feb. 16, 1861. At 8h 15′ A. M., in latitude 16° 7′ N., longitude 144° 49′ E., sun's altitude was found to be 30° 18′. The observed magnetic azimuth was S. 69° 15′ E. Eye was 17 feet. Index error, 1′ 39″. *Required the variation of the compass.*

Question 9.—Compute by Mercator's Sailing, the course and distance from Cape Cod, in latitude 42° 02′ N., longitude 70° 03′ W., to Sierra Leone, in latitude 8° 30′ N., longitude 13° 18′ W.

Question 10.—Compute by Mercator's Sailing, the course and distance from Boston Light, in latitude 42° 19′ 30″ N., longitude 70° 53′ W., to Cape of Good Hope, in latitude 34° 22′ S., longitude 18° 30′ E.

Question 11.—A ship in latitude 50° N., longitude 16° W. Sail south-westerly until her departure is 200 miles, and then at noon by observation is in latitude 47° 59′ North. *Required her course, distance, and longitude in.*

Question 12.—A ship in latitude 42° 50′ N., longitude 59° W., sails S. W. by S. 300 miles per log. *Required the latitude and longitude in.*

Question 13.—Nov. 1, 1861. Latitude 47° N., longitude 68° 15′ West, "per log" at 11h 28′ 30″, A. M. Sun's altitude was 28° 18′, bearing South by West, per compass. At 2h 58′ 20″, P. M. Sun's altitude was 16° 40′ S. Ship's course during the elapsed time, was N. E. at 6 miles per hour, and making ½ point leeway with the wind N. N. W. Eye 19 feet high. *Required the latitude of ship ?*

Question 14.—December 3d, 1861. In latitude 35° 08′ N., longitude 68° 15′ W., per log. At 11h 30′ 45″, A. M., sun's altitude was 32° 18′ S. At 1h 30′ 45″, P. M., sun's altitude was 25° 11′ S. At the time the first sight was taken the sun bore S. by W., and the ship's course during the elapsed time, was S. W. at 6 knots per hour. Eye 19 feet high. *Required the latitude of ship ?*

Question 15.—June 24, 1866. In latitude 26° 49′ N. "per log," at sunset, the sun's upper limb was taken. Time by chronometer, 12h 35′ 14″, it was fast of Greenwich time 2 minutes. *Required the mean time, and longitude of ship ?*

Question 16.—July 5, 1866, at 11h 03′, P. M. per watch, the observed altitude of the Pole Star was 51° 20′, height of Eye 16 feet. *What would be the latitude ?*

Question 17—March 13, 1866. In longitude 67° 30′ West. An altitude of the Pole Star was 53° 51′, time per chronometer 8h 10′ 12″, A. M. Height of eye 12 feet. *Required the latitude of ship?*

Question 18.—Jan. 25, 1861. In latitude 38° 42′ N. "per log." The sun's lower limb at sunrise, was observed by a Spy Glass, at 10h 15′ 20″ per chronometer. *Required the longitude of ship?*

SEAMANSHIP.

IN ADDITION TO SECOND MATE'S EXAMINATION.

Question 1. Box-haul a ship short round, or wear short round?

" 2. Club-haul a ship off a lee shore, when she can neither tack or wear?

" 3. How will you back and fill in a tide way?

" 4. How will you heave to, after scudding?

" 5. What would you do, if taken aback in the night?

" 6. What would you do if scudding, and your ship broached to?

" 7. What would you do if scudding, and your vessel was brought by the lee?

" 8. If your vessel was thrown on her beam ends, when under a press of sail, what method would you take to right her?

" 9. Should you lose a rudder, what is the first thing to be done, and how would you fit a temporary rudder?

" 10. A heavy squall is approaching, and all sail is set. Vessel close hauled, what is your best plan?

" 11. You are coming in to port. Get your vessel ready to come to an anchor?

Question 12. What is the common method of mooring a ship?

" 13. Your vessel being moored, she swings so as to get *foul hawse*, how do you *clear hawse?*

" 14. How do you unmoor ship?

" 15. How do you *cat* and *fish* your anchor, and stow it?

" 16. How do you get under way, and stand out on the wind?

STOWING CARGO.

Question 1. How are owners, masters and mates considered in law?

" 2. How does the law hold the ship-owner liable?

" 3. How must goods be received on board?

" 4. How will you stow and dunnage, hemp, flax, wool, cotton, &c.?

" 5. How stow and dunnage, corn, wheat, rice, peas, beans, &c.?

" 6. How stow and dunnage, oil, wine, spirits, beer, molasses, &c.?

" 7. How stow and dunnage, tar, turpentine, rosin?

" 8. How stow and dunnage, moist goods, as salted hides, bacon, butter, lard, &c.?

" 9. How stow and dunnage tea, flour, coffee, cocoa?

" 10. How stow and dunnage an entire cargo of sugar, saltpetre, or guano in bags?

" 11. How stow and dunnage ashes, tobacco, bark, indigo, madders, or gum in casks, and bales?

QUESTION 12. How stow and dunnage metals, bundle iron, rods, pigs of copper or iron?

" 13. How stow and dunnage miscellaneous goods, such as cheese, lard, dry goods, &c.?

" 14. How should bale goods be stowed in midships?

" 15. How should they in the wings?

" 16. How should bar, and rail road iron be stowed?

MASTER'S EXAMINATION.

IN ADDITION TO THE FIRST MATE'S EXAMINATION.

QUESTION 1.—June 15, 1861. At 3h 45′ P. M., running out by Cape Cod, which bore south, distance nine miles, obtained three altitudes of the sun, and noted the time by chronometer. Mean of the times, 8h 26′ 30″, mean of the altitudes, 39° 50′ 13″. Eye was 19 feet high. Thermometer stood at 65°, and the barometer at 29 inches. Latitude of ship was 42° 12′ N. Longitude of Cape Cod 70° 04′ West. The error of the chronometer as given on shore was 1 minute fast. *Required the error of the chronometer by observation.*

QUESTION 2.—June 15, 1861. In the afternoon at Boston, In latitude 42° 21′ 15″ N. Longitude 71° 04′ West. Observed several angular distances of the sun's lower limb, from its reflected image in an artificial horizon, and noted the time by a chronometer, mean of the time 7h 57′ 23.″ Mean of the altitudes 90° 31′ 20″, time per watch 3h 50′ P. M. Thermometer stood at 76 degrees, and the barometer 30 inches. The error of the chronometer was supposed to be 2′ 29″.3 slow of Greenwich mean time. *Required the error of this chronometer by observation.*

QUESTION 3.—January 14, 1861. In longitude 39° 42′ W. Observed the meridian altitude of the moon's lower limb, which was 60° 00′ 15″, bearing South. Eye 19 feet. Index error 1′ 18″—subtract. *Required the latitude of ship?*

QUESTION 4.—Feb. 19, 1861, P. M. at ship. In longitude 64° 09′, West. Observed the meridian altitude of the moon's lower limb which was 49° 30′ 10″. Eye 18 feet high. Index error 1′ 18″—subtract. *Required the latitude of ship?*

QUESTION 5.—June 17, 1861. In longitude 165° E., altitude of the moon's upper limb, was 70° 12′ N. Eye 19 feet high. *Required the latitude of ship?*

QUESTION 6.—July 1st, 1861. Required the meridian passage of the planet Jupiter, at Cape Cod, also her meridian altitude, and the latitude of the Cape.

QUESTION 7.—June 17, 1861. Latitude in 32° 15′ N. Altitude of planet Venus west of the meridian was 32° 15′ N., time per chronometer 9h 15′ 20″ P. M. Eye 17 feet high. *Required the longitude of ship?*

QUESTION 8.—March 1st, 1861. In longitude 37° W., observed the meridian altitude of the star *Aldabaran*, which was 48° 45′ 30″, bearing South. Eye 21 feet high. *Required the latitude of ship?*

QUESTION 9.—December 3, 1861. In longitude 175° E. observed the meridian altitude of the star *Arietis*, which was 46° 20′, bearing N. Eye 20 feet high. *Required the latitude of ship?*

QUESTION 10.—December 26, 1861. In longitude 165° W., observed the meridian altitude of the star *Canopus*, which was 67° 30′ bearing S. Eye 18 feet high. *Required the latitude of ship?*

QUESTION 11.—March 15, 1861. In latitude 42° 30′ N., altitude of the moon's lower limb W. of meridian, was 58° 30′ S., time per chronometer, 14h 20′ 18″. Eye 19 feet high. *Required the longitude of ship?*

QUESTION 12.—Nov. 1, 1861. In latitude 45° N., longitude 65° 19′ W. per log., at 11h 15′ 20″ A. M. per watch, regulated 35′ to the eastward of the ship. Sun's altitude was found to be 29° 15′ S. Eye 15 feet high. *Required the latitude at time of observation?*

QUESTION 13.—Nov. 15, 1861. In latitude 36° 28′ N.

longitude 50° per log, at 1h 35′ 40″ P. M. per watch, regulated 40′ to the westward of ship. Sun's altitude was 30° 17′ S. Eye 17 feet high. *Required the latitude at time of observation?*

Question 14.—June 19, 1861. Sun's observed altitude A. M., was 85° 40′, time per chronometer 1h 46′ 10″. Sun's observed altitude P. M. was 85° 40′, time per chronometer 2h 12′ 26″. *Required the longitude of ship at noon, by equal altitudes?*

Question 15.—Nov. 1, 1861. Sun's observed altitude A. M., was 68° 20′, time per watch 11h 20′ 00″ A. M. Sun's observed altitude P. M., was 68° 20′, time per watch 12h 34′ 06″, P. M. *Required the longitude at noon, by equal altitudes?*

Question 16.—Your ship has sailed from yesterday noon until to-day at noon (per log) N. 47°, E., dist. 130 miles, but by observation, she has sailed N. 37° E., dist. 147 miles. *Required the set, and drift of the current?*

Question 17.—Your ship was yesterday at noon, in latitude 30° 10′ N., and longitude 30° 20′ W., and until noon to-day, has made by log 55′ .5 N., difference of latitude, and 80′ .7 W. departure, but by observation it was found she was in latitude 31° 20′ N., and longitude 32° 05′ W. *Required the drift, and the set of the current?*

Question 18.—*Lunar observation.* Boston Nautical College, July 2, 1861. Distance was measured between the sun and moon, N. L., and was found to be 63° 07′. Sun's altitude was 42° 36′, and moon's altitude was N. L., 62° 23′. Time per watch was 8h 34′ 59″ A. M. *Required the longitude of the college?*

Question 19.—*Lunar observation.* Sept. 10th, 1861, P. M., at ship, time per chronometer, 1h 05′ 18″. Observed distance between the sun, and moon's nearest limb, was 78° 56′ 50″. Sun's altitude 20° 01′ 10″. Index error 47″ add. Eye 20 feet high. *Required the longitude and error of chronometer?*

CHARTS.

Question 20.—Place ship on Chart having latitude and longitude?

" 21.—Place ship on chart by cross bearings?

" 22.—Place a ship on Chart by latitude and soundings?

" 23.—Place ship on chart by two bearings of the same object?

" 24.—Place ship on chart by soundings, and bearing off a light?

" 25.—Place ship on chart by Sumner's method, and obtain the latitude and longitude, distance off the land, and variation of compass?

Question 26.—Shape a course and distance, from one port to another, and from ship to port?

Question 27.—Place a ship on the chart, and obtain the distance off a light, when you first make it on the horizon?

Question 28.—Measure off a distance on the chart, between two places, when they bear N. and S., and when they bear E. and W., from each (other) shape a course to come too in a roadstead, in a given depth of water?

☞ Also miscellaneous questions in Navigation will be asked, such as the definitions of astronomical terms, meaning of the various corrections used in working navigation problems, and also the nature of Bill of Lading, Invoice, Manifest, Bottomry Bond, Charter-party, &c.

SEAMANSHIP.

IN ADDITION TO FIRST MATE'S EXAMINATION.

Question 1.—How will you heave too, after scudding under a close-reefed maintopsail, and reefed foresail?

Question 2.—Get under way, from a single anchor?

Question 3.—Get under way, head to tide, wind abeam, cast to starboard?

Question 4.—Get under way, riding head to the wind, with a rock close astern?

Question 5.—Get under way, with a tide setting to windward, and cast to port?

FIRST CLASS MASTER, EXTRA.

This extra examination is intended for Masters of large ocean steamers, and in addition to the First Class Master's examination, will be as follows:—

NAVIGATION.

Question 1.—Have you a knowledge of the law of storms?

Question 2.—What is your idea of a cyclone?

Question 3.—Can you calculate the bearing of its centre from your ship?

Question 4.—How many points does the centre of a revolving storm bear from the direction of the wind, at the ship, reckoned with the course of the sun?

Question 5.—In your usual course to the West Indies, after passing longitude 50° W., you observe unmistakable signs of a hurricane bearing down on you, wind steady, N. E., trades, but increasing, with strong, and sudden squalls, and the ship just upon the N. W. margin of the cyclone; how does the centre bear from the ship, and what tack should you heave too on?

Question 6. If the N. E. wind, instead of being steady, should be replaced by a violent wind from the North, how would the centre bear from the ship?

Question 7.—If you should lie too on the starboard tack, what wind would you experience?

Question 8.—What is the rule for the hauling of the wind in a revolving storm in the northern hemisphere, in a port semi circle?

Question 9.—What is the rule for right hand on starboard semi-circle?

Question 10.—If you should take the storm N. E., and scud before it, should you be going to, or from the centre?

Question 11.—How is the barometer effected while the first half of the storm is passing the ship?

Question 12.—How while the succeeding half passes?

Question 13.—If a cyclone be moving N. N. E., and your ship W. S. W., wind from S. E., will you be running to, or from the centre of the hurricane?

STEAM.

This examination *will probably* be conducted under the superintendence of the *Marine Boards*, the examiner being an engineer, selected by the board for that purpose.

BOILERS.

Question 1.—How do you ascertain the saltness of the water in the boilers?

Question 2.—How would you manage to change the water in the boilers, if the blow off cock were set fast?

Question 3.—On examining the boilers, they are found to be thin, what measures would you adopt to prevent accident?

Question 4.—How would you keep the boiler free from salt, and incrustation?

Question 5.—Is it requisite to have a hand pump fitted to the boilers, if so for what purpose?

Question 6.—Explain the use of the guage, glasses and guage cocks, fitted on to the boilers?

Question 7.—If the mercury was blown out of the steam guage, by the pressure of steam in the boilers, what would you apprehend was the cause?

Question 8.—What would you do to relieve the pressure of the boilers?

Question 9.—How would you regulate the hight or quantity of water in the boilers?

Question 10.—When steam is up, how is the feed applied to the boilers?

Question 11—When it is not up, what is necessary to be done before the fires are lighted?

Question 12.—When the engines are stopped, what precautions are necessary with regard to the water in the boilers?

Question 13.—What is meant by a boiler priming?

Question 14.—How would you prevent it doing so?

Question 15.—If the water in a boiler is suffered to get too low, what may be the consequences?

Question 16.—What hight should the water stand in a common boiler, above the tubes?

Question 17.—What hight should the water stand in a tubular boiler, above the tubes?

Question 18.—If any of the tubes were damaged by the fire, or leaky, what would you do, supposing you could not shift them?

Question 19.—How do you detect the pressure of steam in a boiler?

Question 20.—If the water in a boiler is suffered to get too high, what might be the consequences?

Question 21.—How do you know when the water in the boiler requires changing?

Question 22.—Explain the use of the thermometer and hydrometer?

Question 23.—If your safety valves were set fast, how would you relieve the pressure on the boilers if steam was up, and could not make its escape?

BOILER VALVES AND COCKS.

Question 1.—What are safety valves?
" 2.—What are reverse or atmospheric valves?
" 3.—What are communication or stop valves?
" 4.—What are feed valves?
" 5.—What are kingston valves?

QUESTION 6.—What are blow off cocks?
“ 7.—What are water guage cocks?
“ 8.—What is a steam guage?
“ 9.—What is a hand pump for boilers?

ENGINE VALVES AND COCKS.

QUESTION 1.—What are throttle valves?
“ 2.—What are side valves?
“ 3.—What are expansion valves?
“ 4.—What are escape valves?
“ 5.—What are blow through valves?
“ 6.—What are foot valves?
“ 7.—What are delivering valves?
“ 8.—What are air pump bucket valves?
“ 9.—What are injection valves and cocks?
“ 10.—What are bilge pump valves, and cocks?
“ 11.—What are stop, or sluice valves?
“ 12.—What are jacket cocks?
“ 13.—What is the snifling valve?

ENGINES.

QUESTION 1. Explain the use of the Cylinder?
“ 2. “ “ “ Air Pump?
“ 3. “ “ “ Condenser?
“ 4. “ “ “ Eduction Pipe?
“ 5. “ “ “ Hot Water Cistern?
“ 6. “ “ “ Piston, and how fitted?
“ 7. Explain the use of the Stuffing Box and Glands?
“ 8. Explain the use of the Parallel Motion Rods?
“ 9. Explain the use of the Eccentric, and how fitted?

QUESTION 10. Explain the use of the Starting Lever?

" 11. Explain the use of the Barometer?

" 12. Explain the use of the Steam Guage?

" 13. Your vessel being alongside the wharf, proceed to get up steam?

" 14. Your steam up, how do you apply it to the engine to set it in motion?

" 15. What precaution is necessary, before the engine is set in motion?

" 16. How do you start the engine?

" 17. Is it necessary to move the engine by hand a turn or two before starting?

" 18. Your engines being started, regulate the Injection Cocks, so as to keep them going at full or reduced speed?

" 19. What is the use of the Injection?

" 20. How is the vacuum maintained in a condensing engine?

" 21. How do you know when there is too much injection?

" 22. How do you know when there is not enough injection?

" 23. If the injection was not shut off when the engines are stopped, what would happen?

" 24. If the condenser reject the injection, what would you do?

" 25. Would it be advantageous, if an injection pipe was fitted so as to take injection from the bilge, if required?

" 26. If water should get into the cylinder, what might be the consequences?

" 27. In running free with a heavy sea, and a jump upon the engines, what precautions would you take to endeavor to prevent damage to the engines?

Question 28. If one engine was damaged, what would you do in order to proceed?

“ 29. If the eccentric should break, could the engine still be worked?

“ 30. If a bearing becomes heated, what would you do?

“ 31. How would you slow an engine?

“ 32. How would you stop an engine?

“ 33. Wherein does a high pressure differ from a low pressure engine?

“ 34. How do you admit tallow into the cylinder, when the engines are at work, for the purpose of lubricating the pistons?

“ 35. What is meant by working the engines expansively?

“ 36. How would you disconnect the engines if there was no disconnecting gear fitted?

“ 37. What is meant by throwing the engine out of gear?

“ 38. Why have two feed-pumps fitted, say one for each engine?

“ 39. Is it requisite to have branch pipes fitted to the feed pumps, if so for what purpose?

NOTE.

In the examination for an assistant engineer, he will be provided with *drawings* and working *sections*, on a large scale, of the various parts of a steam engine, valves, slides, &c., &c., and must answer the various questions put to him; and it must be borne in mind, that nothing but a *practical knowledge* of the steam engine, in all its details, will enable the candidate to pass the board of Examiners for an assistant engineer, and this practical knowledge can only be acquired by spending some time in an *Engineer's* work shop.

Masters and Mates in the coasting trade, for their examination, are referred to page 9.

THE THREE COASTING DISTRICTS

For the convenient regulation of the Coasting trade, the sea coast and navigable rivers of the United States are divided into *three great districts*. The first includes all the districts on the sea coast and navigable rivers between the *eastern limits* of the United States and the *southern limits of Georgia;* the second includes all the districts on the sea coast and navigable rivers between *the river Perdido* and the *western limits* of the United States; and the third includes all the ports, harbors, sea coasts and navigable rivers between the *southern limits of Georgia and the river Perdido*. And a licensed coaster may trade within the limits of either of the great districts without being obliged to clear or enter at the custom house, provided he has not on board a certain amount of *distilled spirits*, or *foreign merchandize*, if he has he must make out duplicate manifests of the whole cargo, specifying *marks and numbers* of every package with the name and residence of every shipper, and should he sail without doing so, he will forfeit 100 dollars.

EXPLANATION OF THE PRINCIPAL ASTRONOMICAL TERMS USED IN NAVIGATION.

ARCHRONICAL rising or setting of a planet is when it rises at sunset, or sets at sunrise.

ALTITUDE is the hight of the sun, moon, or stars above the horizon, reckoned in degrees, minutes, &c.

MERIDIAN is a great circle which passes through the zenith and poles, and is perpendicular to the horizon. When the sun is upon this circle, it is midday or noon.

DECLINATION is the distance of the sun, moon, and stars North or South from the equator.

PARRALLAX is the difference between any celestial object as seen from the surface of the earth and from its centre.

REFRACTION of a body is the quantity which that body appears above its true place in the heavens, and is caused by the turning of a ray of light from a straight course.

Polar Distance is the distance of the object from the elevated pole, from the North in North Latitude, and from the Nadir in South Latitude.

Right of Ascension is the distance of a heavenly body from the first of Aries on the equator; in other words, is that degree of the equator which comes to the meridian with the sun, moon, or stars, reckoned from the first point of Aries.

Radius is a line from the centre of the circle to the circumference.

Zenith is the point in the heavens directly overhead of the observer.

Horizon is a great circle of the earth, 90° from the zenith, and is called the rational horizon. The sensible horizon is the circle that bounds our sight. A horizon at sea would be called a sensible horizon.

Semi-diameter of the sun or moon, is a correction necessarily applied in order to reduce the altitude to the centre of the body.

Equation of Time. The sun has been used as a measure of time from the remotest antiquity, yet it is far from being uniform. The sun is either faster or slower than a well regulated clock or watch, during most of the year; at four times only do they coincide, on the 14th of April, 15th of June, 31st of August, and 23d of December. Equation, then, is the difference between the clock and sun time.

Dip of the Horizon is caused by the eye of the observer being elevated above the horizon at his feet.

Amplitude is an arc of the horizon, contained between the east and west point of the heavens.

Azimuths are great circles which pass through the zenith and nadir, and are perpendicular to the horizon, and are the distance of a heavenly body from the north or south point of the horizon when the body is on that circle.

Axis is an imaginary line passing through the earth's centre.

Artificial Day is the time between sunrise and sunset.

Astronomical Day is the time between two successive transits of the sun's centre over the same meridian, which always begins and ends at noon.

Civil Day is the time between midnight and midnight, and is 24 hours.

Sea Day commences at noon; 12 hours before the civil day and ends at noon of the civil day, the first 12 hours are marked P. M., and the last 12 hours A. M. A ship's log is generally kept by this time.

Equator is a great circle which divides the northern from the Southern hemisphere, and being referred to the heavens, is called the Equinoctial.

Cycle is a period of time.

Diurnal, belonging to the day; diurnal motions are daily motions.

Ecliptic is a great circle,—the sphere in which the sun always appears to move,—the angle it makes with the Equator is about 23° 28′.

Zodiac is a broad circle in the heavens between two lines on each side of the ecliptic, and parallel to it at 8° distant.

Elongation is the angular distance of a planet, from the sun, as it appears to us upon the earth.

Emersion is the time when a planet that is eclipsed begins to recover its own light.

Equinoxis is the two points where the ecliptic cuts the equator, and is so called because the sun in either of these situations, the days and nights are equal to each other.

Latitude of a star, or planet, is its distance from the ecliptic.

Longitude of a star, or planet, is its distance from the first point of Aries, reckoned in degrees and minutes.

Longitude of a place, is its distance from Greenwich, east or west.

Lunar Months is the time between one new moon and another, which is about 29 days, 11 hours and 44 minutes.

Quadrant is the fourth part of a circle.

Octant is an aspect of the stars, or planets, when they are 45° distant from each other.

Sideral, belonging to the stars or planets.

Sideral Year is the time the sun takes in moving through the ecliptic, from any fixed star to the same star again.

Transit is the passing of one celestial body before another, so as to render any part of it invisible.

Twilight is a faint light we see before the rising of the sun, and after his setting, and is occasioned by the refraction of the earth's atmosphere.

Cosines, Co-Tangents, and **Co-Secants** are sines, tangents and secants of the compliment of an *arc*.

Solstice. The time when the sun is farthest from the equator, and the days are longest or shortest; when the days are the longest it is called *mid summer*, when the shortest *mid winter*.

Planets and Stars

GENERALLY USED IN NAVIGATION.

Fixed Stars are so denominated from their always retaining the same situation in relation to each other. They may be distinguished from the planets by the twinkling of their lights. Many stars appear single to the naked eye, which, on being viewed through a good telescope, are found to consist of two or three stars; these are called *binary or double stars*. The *Polar Star* is a binary, and is composed of two stars of very unequal magnitude, the largest is *white*, and the smallest is *red*.

Arietis, the North Star, always bears west, distance 23° from the Pleiades, or seven stars, and is 1° 42′ S. of the North Pole, and is of the second magnitude; and the two stars in the pleiades most distant from the tail, are called the pointers, as they point directly to the North star, which is distant from them 23 degrees.

Aldabaran. This star which is of the third magnitude, bears E. by S. 35° from the *North Star*, and is of a bright red color.

Pollux. This star, which is of the second magnitude, bears E. N. E. from *Aldabaran*, distant 45°, and N. W. from it is the star *Castor*, distance 5°.

Regulus. This star is of the first magnitude, and bears from *Pollux* E. S. E., distant 37° 30′.

PLANETS.

The best planets to use in Navigation are *Venus*, *Mars*, *Jupiter*, *Saturn* and *Mercury*, and they are easily distinguished from the *fixed stars* by their steady light; they never twinkle, except when near the horizon.

Venus, which is the brightest of the planets, is of a brilliant white, and when she is West of the *sun*, she rises before him and is called the *morning star*, when she is east of the *sun*, she shines in the evening, after he has set, and then is called the *evening star*. Her diameter is 7498 miles, and her magnitude a little less than that of the Earth.

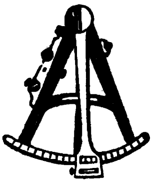
Mars is of a dusky red color, some times he rises before the sun and is seen in the morning; at other times he sets after the sun and is seen in the evening. His diameter is about 4218 miles, and his magnitude one seventh of the earth.

Jupiter is the largest of the planets; when he is west of the sun he will be in the east before the sun rises, and will be the *morning star*, when he is east of the sun he will be the *evening star*. His diameter is about 89,069 miles; his magnitude 1400 times that of the earth. He is attended by four statellites, or moons, which revolve around him.

Mercury. This is the nearest planet to the sun, it shows a brilliant white light, and is the *swiftest* of all the planets, its surface contains 32 millions of square miles, and like *Venus* it is alternately a *morning* and *evening star*, though not generally thus known. When west of the sun he rises before him in the morning; when east of the sun he sets after him in the evening.

Moon. The moon is 240,000 miles from the earth, and its diameter 2,180 miles; and the side which is next the sun is enlightened, the other half is dark, and invisible. When she has advanced a little way in her orbit, a small part of her illuminated side becomes visible, this is the *new moon*. When she becomes opposite the sun nearly the whole of her enlightened hemisphere is presented to the earth. She is then called the *full moon*.

NOTE.—In taking the planets or fixed stars for navigation purposes, the horizon must be distinct and well defined, and the planets should be bisected on it, or in other words their centre brought to the horizon. The nautical almanac will give the time of the planets, and fixed stars, coming to the meridian, for every day in the year, and the necessary corrections for them; in the present improved state of the nautical almanac, we have the declination for the moon laid down for every hour during the day, and side corrections for every minute of time; the moon being so near the earth, her changes are very rapid, therefore to work the moon with accuracy her corrections must be taken out to the nearest minute. While the sun, which is over 96,000,000 of miles from the earth, changes so slowly that his corrections can be taken out for every 12 hours for common purposes at sea.

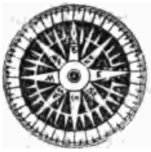


LECTURES ON NAVIGATION DELIVERED BEFORE THE BOSTON NAUTICAL COLLEGE, BY CAPT. ERASMUS THOMPSON.

NAVIGATION.

LECTURE No. 1.

The safety of commerce depends much on the improvement of navigation, and at the same time contributes to increase the wealth of our merchants and public revenue, and a proper experience in this art should be the chief concern of those who undertake the navigation of a ship, whereby the lives and fortunes of men are committed to their charge. Every commander or officer navigating a vessel should be furnished with good instruments, and requisite epitomes of navigation, and they should be required to thoroughly understand and be expert in the practice of them, which by *proper instruction* they can become. The simple knowledge of obtaining latitude at noon or a sight for the chronometer in the morning, laying off a course on the chart, and keeping a log, does not make a navigator, any more than knowing how to handle a chisel or a plane makes a carpenter. A commander of a vessel should be able to take his sextant, measure a distance between the sun and moon, or star, and find his true position by it. He should also be able to take a sight and work it correctly of the sun, moon, planet, or fixed stars, and understand thoroughly all the *new methods* of navigation. He should also thoroughly understand amplitudes, and azimuths, (which are of vast importance) to enable him to correct any errors of his compasses which may arise on ship board, for there are many things which may produce an error in his compasses, which are the most important instruments he has on board, for without them how can he find his way across a trackless ocean?



COMPASS.

In regard to this instrument, it is said that the attractive power of the magnet was known in Europe six hundred years before the christian era, and by the Chinese records it is said that its directive properties were known in that country at least a thousand years earlier. The invention of the compass is ascribed to *Flavia Goya*, of Naples, about the year 1302. The variation of the needle was discovered by Columbus, in Sept., 1492, and soon after it was found to be different at different places. This difference was called the variation of the compass and was east or west as it deviated from the true *magnetic north*, one side or the other. Lines of variation were laid down upon the charts which were supposed to show the variation at those places, but no great dependence could be placed on them until Mr. Barlow, of the Royal Society of London, in 1823, published a valuable chart, in which the magnetic lines of equal variations were laid down as they had been observed in voyages of discovery and government surveys. In the year 1859 he prepared a valuable table for the use of navigators, giving the variation in every parallel of latitude, each side of the equator, both in east and west longitude. Now it may interest you to know that the common sewing needle possesses polarity; when floated on water, it will tend to the magnetic meridian, the point tending to the South. And this will be well for all seamen to know, for should they be so unfortunate as to quit their vessel without a compass, by the use of a common sewing needle they are supplied with a tolerable substitute, for a dry needle *gently dropped* on the surface of the water will swim unless the upper part becomes wet, and if several needles be rubbed from the middle towards the point with the back of a knife, (*which will excite a strong polarity*) and then stuck together, through a small piece of cork, with their points one way, they will move with a much quicker motion than either of them single.

I shall next proceed to show you some of the causes of

LOCAL ERRORS

on board ship. That these errors exist from some cause is well known. In the first place a compass will differ very materially from itself on being removed from one part of a ship to another. Therefore the position of the compass must be confined to one particular spot on the ship, and the place is generally the binnacle on the quarter deck. Care should then be taken to examine the compasses to see if they are not effected by something on board, the stove pipe coming up through the deck, for hot iron has much greater influence on the needle than cold iron, or iron nails, iron rods or bolts, for it is a well known fact that a bar of iron standing in a vertical position for a length of time will become magnetic, and if it remain so for 14 years it will become a complete magnet. Now the usual method of ascertaining this important error is to moor the ship so that her head can be swung round to all the four cardinal points of the compass, N. S. E. W., her head being pointed first due north by the compass on deck, another compass is taken on shore. Now if the ship's compass make the head of the ship due north, and the compass on shore makes the ship's head bear due south, there is little or no local error, but if the ship's compass points due north, and the shore compass makes the ship's head bear S. by E. or S. by W., then there is a local error on board, and the difference between the compasses is that error. But to ascertain this the ship must be swung round to each of the cardinal points, therefore you can see how much care is required to keep this little important instrument in order that the mariner may find his way truly and safely.

Too many incompetent men command and hold important positions on shipboard. But our merchants and underwriters are waking up to a proper sense of the importance of this matter. They are establishing *Ship Master's Boards* in all the principal seaports, for examination of officers in the *merchant service.* And this is as it should be; and the young man who intends to make the sea his profession, should therefore thoroughly qualify himself in this most *important branch of Navigation,* if he wishes to rise to a first class commander.

Now let us see what are the qualifications for a first class commander.

In the first place he should be a good navigator, in the second place a good seaman, and in the third place a good factor or merchant. Wherefore the young man preparing for sea, the young officer expecting promotion, can see what is required of him to enable him to take high rank on the quarter deck. He should also possess a general knowledge of all the different instruments; which with his knowledge of navigation will enable him to form a correct judgment in regard to the weather, winds, tides, &c. As for instance the *Hygrometer* will enable him to measure the moisture and dryness of the air, and whether he is to have rain or fair weather. The *Barometer* will assist him to anticipate a *storm* or *hurricane,* and with proper knowledge and attention he can make and take in sail with perfect confidence. The *Thermometer* will enable him to determine if he is in the *gulf stream* or vicinity of *ice,* and will prevent him from coming in contact with *icebergs.* The timely use of this little instrument has saved many a ship. There are also many other things that the nautical student should thoroughly understand. In the first place the

TIDES.

The ocean it is well known covers more than one half of the globe, and this large body of water is found to be in continual motion. Ebbing and flowing alternately without the least intermission. Now the moon has connections with these motions; for instance, if the tide be now at high water mark in this harbor, it will presently subside and flow regularly back for six hours, when it will be found at low water mark, after this it will again gradually advance for six hours and then return back in the same time. The interval however between its flux and reflux is not precisely six hours, but about 12 minutes more, so that the time of high water does not always happen at the same hour, but about three quarters of an hour later every day for thirty days, when it again recurs as before. For example, if it be high water at Boston to-day at noon, it will be low water at (12) minutes after 6 o'clock in the evening, and consequently after two changes more the time of high water the next day will be about three quarters of an hour after noon. The following day it will be about half an hour after one, the day after that at a quarter past two, and so on for thirty days, when it will again be found to be high water at noon, the same as on the day the observation was first made. Now this exactly answers to the motion of the moon. She rises every day about three quarters of an hour later than the preceding one, and by moving in this manner round the earth completes her revolutions in about thirty days and then begins to rise again at the same time as before. Therefore the student will see that a thorough knowledge of these principles will enable him to calculate the time of high water in any part of the world, which is often of vast importance to him, on entering a harbor. In the second place the

WINDS OF THE OCEAN.

It is well known that wind is a current of air put in motion which is produced by a partial change of temperature in the atmosphere, one part becomes more *heated* than the rest, that part becomes more rarefied and light, and the equilibrium is destroyed. When this happens the surrounding air rushes towards that part in order to restore it, this spot therefore receives wind from every quarter. Now those who are to the northward of it experience a north wind, and those to the southward a south wind.

THE TRADE WINDS,

So called, are produced by a combination of two winds, *north and east*, and produce a constant *north east wind*, the two winds *south*, and *east*, produce a regular *south east* wind. Now these winds rarely extend farther than 30° each side of the equator.

MOONSOONS,

which change their course every six months, are produced by the earths annual course round the sun, the north pole being inclined to the sun one half of the year, the south pole the other half. The

SEA BREEZE

observable on islands and other sea shores in the tropics, is only an effort of the atmosphere to restore its equilibrium which has been caused from the heated surface of the land, Now when night has cooled the land and condensed the air, it is generally found to flow back to the sea.

HURRICANES.

rage with the greatest fury near the tropics and generally in the vicinity of land or islands.

NORTHERS

are found mostly in the West Indies during the months of November, January, February and March.

TORNADOS

which are found on the coast of Africa, are so called from their coming up from the leeward against the regular trade winds. In the year 1860 I was on the west coast of Africa, in command of a clipper brig belonging to Rich, Thompson & Co. of Boston, and I experienced one of the most terrific tornados which had been known on that coast for years. On its first appearance we had a fine breeze from the westward. All sail was immediately handed except the fore-topmast-staysail, which was kept out to veer under. It blew furiously for about one hour with heavy thunder and lightning, and torrents of rain. The air was so charged with electric matter that no person could touch the chains without receiving an electric shock. The compass fluttered and turned round. The mercury in the barometer stood very low, and the flashes of lightning were fearful. We had however the good fortune to safely ride it out.

WHITE SQUALLS

generally happen near the land and blow with great violence, but are of short duration. They indicate their approach on the surface of the sea. They appear like a line of white water thrown up by the force of the wind and are very dangerous.

WHIRLWINDS.

It is the opinion of Prof. Arnold that they are caused by a sudden *rarefaction* of air in a small compass, occasioned by electricity in the atmosphere, in which case the surrounding air being much heavier, rushes from all sides into this space of rarefied air and being in that space still much lighter above than below, occasions a constant current of air to run up. He is also of opinion that water spouts are formed on this principle, the water being drawn up from the sea.

VAPORS

are composed of water particles from the surface of the water, and by sun's heat are rarefied and thinned and separated from each other, and becoming lighter than the air they rise and float in the atmosphere.

FOGS

are a collection of these vapors and become more visible as the light of day advances.

CLOUDS.

are vapors exhaled from the sea and land, and their hight never exceeds two miles. The generality of clouds are rarely higher than one mile. The variety of colors is owing to their particular situation in regard to the sun, and the different reflection of light.

RAIN.

When the weight of the air is diminished the vapor that floats in it will begin to fall, and as they strike one upon another in falling they unite and form small drops, and when a cloud consisting of these drops are united into such large drops that no part of the atmosphere is dense enough to support them, they *must fall* to the earth, and this is called rain, and these drops increase in bulk as they descend, being much larger than they were higher up in the atmosphere.

THUNDER AND LIGHTNING.

The atmosphere is the common receptacle of all the effluvia arising from different bodies, now when effluvia of sulphurous and nitrous bodies meet each other in the air there is a strong conflict between them which is so great as to produce fire. If the inflammable matter be thin and light it will rise in the atmosphere and will flash without doing any harm, but if it be dense it will lie near the surface of the earth, take fire and explode with surprising force, accompanied by terrible claps of thunder. And in conclusion I would say to you when on board of a ship always keep at a distance from the masts in a thunder storm, and when on land from trees.

Lecture No. 2.

A thorough understanding of the science of Navigation is indispensable to every ship-master, to every subordinate officer, and to every young man whose purpose is to follow the sea as a profession. To the ship-master, because the safety of his vessel, his passengers, his crew, his cargo and his owner's interests depend upon his information and ability. To the subordinate that he may be equal to any emergency that may come up during a voyage. To the man before the mast and the boy, that their advancement may be sure and speedy. The importance of systematic instruction in this branch of education is daily being advocated by those of great influence in the naval interests of the nation. Schools and boards of examination are being established by the Boards of Trade in our principal sea-ports, and energetic measures are being adopted for the advancement, in this manner of the commercial interests of the country.

It will be my endeavor to make these brief lectures upon the science of navigation, instructive, not only to those who "go down to the sea in ships," but also to any one who desires information in a most entertaining and useful branch of study. It is my intention to explain the theory of navigation, carefully, systematically and thoroughly. To speak of the qualifications and the requirements of the different officers of a vessel, and explain in full the various duties devolving upon them in their several capacities. The different departments and particulars of the science, such as keeping a log, inspection and projection, finding latitude by sun, moon, planets, and stars, adjustment and manipulation of quadrants, sextants, &c., longitude by chronometer, the use of the various instruments, rating chronometer by sea and artificial horizons, double altitudes, measuring hights and distances, obtaining difficult bearings of land by charts, shaping courses, etc., etc., will be treated methodically and scientifically.

Capt. Barrett of the U. S. Navy, in his lately published work on navigation, in his introductory remarks states that "the greater part of the volunteer officers who entered the navy came before him to pass their examination, and he found a lamentable deficiency in the most of them in the simple preliminaries of navigation—such as keeping a correct log and working dead reckoning." I propose in this lecture to treat on these subjects as plainly as possible, so that all may understand it.

To keep a correct ship's journal, the log should be thrown every two hours, and the ship's rate of speed entered on the log slate, as well as the course she has made. At the end of the twenty-four hours, or sea day, as it is termed, the first officer, whose duty it is to keep the reckoning, sums up the number of miles she has run on the various courses, applying correction for error of compass and leeway, which will give the true courses the ship has made good.

With these true courses enter table first of the navigator, and then find the difference of latitude and departure the ship has made on those courses for the twenty-four hours. Then place all these courses in a traverse table and add up all the northings, southings, eastings and westings separately and set down their respective sums at the bottom of each column. If the southing is greater than the northing, subtract the northing therefrom, and *vice versa*. The remainder will show how far the ship has gone north or south, east or west. The object of this traverse table is to reduce all the courses sailed to a single course, so as to obtain the difference of latitude and departure. Then to the latitude left the day before apply the difference or latitude made, and if of the same name, add them; if of different names, subtract, which gives the latitude the ship has come to that day. Now proceed to find the longitude by adding the latitude the ship has come to the latitude she left yesterday. Half the sum of these two latitudes will be the middle latitude, with which enter table second, using it as a course, and seek in the latitude column for the departure the ship has made. Opposite it in the distance column is the true difference of longitude, which apply to the longitude left. If of the same name, add them; if of different names, subtract, which will give the correct longitude.

Now, having the latitude and longitude of the ship, next proceed to find the distance the ship has run from noon to noon, and the course she has made good. To do this, enter table second of the Epitome again, and find the difference of latitude and departure to agree in their respective columns. Opposite them in the distance column will be the distance the ship has run, and at the top or bottom of the page will be found the course she has made good. Thus every day at noon the latitude and longitude can be obtained; also the distance the ship has run, and the course she has made good.

In the ship's journal must be entered the latitude and longitude of the ship, her courses run, and in the abstract table at the foot of each day's work must be written the difference of latitude and longitude made, the distance run, and the true course.

In the column of remarks must be entered anything of local interest on board, or any transaction that may affect the owners, the insurance, the cargo, or the safety of the ship, as the journal (if brought into court) is considered in the same light as a business man's ledger, and is, or ought to be, a *bona fide* description of the voyage.

It is the duty of the first officer or mate to keep the log, and he must see to it that it contains everything of local interest, and allow no one to make an entry therein but himself, for marine law requires this duty of the first officer of any vessel of one hundred tons burden and upwards.

LECTURE NO. 3.

In this lecture, gentlemen, upon Navigation, I shall explain Declination and its important bearings upon all navigation problems.

In the first place, the declination of the sun, moon, or planets, is their distance from the equinoctial, northward or southward; for when the sun is in the equinoctial, he has no declination, but enlightens the globe from pole to pole. As he increases in north declination, he gradually shines farther over the north pole and leaves the south pole in darkness, and in a similar manner when he has south declination he shines over the south pole and leaves the north pole in darkness. The greatest declination the sun can have is 23° 28′ north or south. The greatest a star can have is 90° north or south. The greatest a planet 30° 28′ north or south. The sun's annual path through the heavens is divided into twelve signs, from right to left, beginning at Aries, and is as follows:

He enters Aries about March 28; Taurus, April 20; Gemini, May 21; Cancer, June 21; Leo, July 23; Virgo, August 23. These are called the northern signs, the sun then having north declination. The sun enters Libra September 23; Scorpio, October 23; Sagittarius, November 23; Capricornus, December 21; Aquarius, January 20; Pisces, February 18. These are called the southern signs, the sun then having south declination. The Nautical Almanac gives the declination of the sun for the noon at Greenwich for every day in the year, which declination is computed for the longitude of 0° (nothing). This declination must be corrected for the longitude of the ship at the time you want to use it. There are two ways to find this correction; one is, by entering table 5th of the Epitome, with the longitude at the top, and the day of the month in the side column; under the former and opposite the latter will stand a correction to be applied to the declination taken from the Nautical Almanac, and at the top of the table you can see whether to add or subtract it. The naval method for correcting the declination is from a side table in the Nautical Almanac itself, as a difference for every hour is laid down by the side of the declination. Now, having a chronometer on board, you know how much it wants of, or is past, the Greenwich noon, and by multiplying this hourly correction by the number of hours before or past noon and applying it to the Greenwich declination, you have the true declination of the place of the ship. Declination being a very important correction, and one which must be used in all navigation problems, it is very important that the navigator should thoroughly understand and know how to correct it before using it.

In applying declination to observations taken with a sextant or quadrant, you first obtain the altitude of the heavenly body and correct it (which corrections will be fully explained in a future lecture) to obtain the true altitude, which altitude subtracted from the angle of 90° will, in obtaining latitude, give you the zenith distance, or the distance of the heavenly body from the zenith. To the zenith distance you apply the sun's corrected declination, and it will give you the latitude of the ship.

LECTURE NO. 4.

I shall now explain the naval method of obtaining latitude at noon by a meridian observation.

Twelve o'clock being the time when the sun passes the meridian, I obtain his altitude by my sextant, and correct this altitude. For index error, if any, add the semi-diameter, and subtract the dip and refraction to obtain the true altitude. I then subtract the true altitude from the angle of 90° to obtain the zenith distance; to this zenith distance I apply the corrected declination, and if the zenith distance and declination are both of the same name, I add them; if of different names, I subtract them, and the result will be the latitude of the ship at noon of that day.

In explanation of the corrections used in this problem—the Index Error is an error of the sextant, if out of adjustment; but if adjusted, there is no Index Error. This error is sometimes additive, and sometimes subtracted. Semi-diameter is half the diameter of the sun. The astronomer measures all heavenly bodies from the centre of the earth; navigators from the surface. Hence this correction to bring our observations to compare with theirs before we can use their tables. Hight of eye, or dip, is the number of feet that the observer stands above the surface of the sea, and is always to be subtracted from the altitude, as it makes his altitude that much too large.

REFRACTION.

All heavenly bodies appear higher than they really are, owing to the dense rays of refraction, as rays of light do not come to us in a straight line; therefore a correction must be found for this error, and always subtracted from the observed altitude.

The declination used must be corrected for the longitude of the ship (as explained in a former lecture), and this should be applied, as stated before, to the zenith distance; this zenith distance being the true distance of the sun from the zenith at the moment of its having done rising; this will give you your latitude in any part of the world.

Lecture No. 5.

Gentlemen: I shall now explain the naval method of obtaining longitude by the chronometer, and the necessary corrections attending its manipulations. The best time to take an altitude for the chronometer is when the sun is rising or falling the fastest, or when it bears nearly east or west, for then a small error in the latitude will not effect the result. There is a variety of opinions among navigators in regard to the best time to obtain a morning sight for the chronometer. My rule invariably has been to obtain an altitude between 18° and 25°, and by allowing for the refraction (which is always large near the horizon) I obtain good sights. Now, having obtained the altitude and noted the time by the chronometer, I correct the altitude by applying the Index Error of the sextant. If there be any, add the semi-diameter and subtract the dip and refraction; to obtain the true central altitude, bring the latitude forward to the time of observations and get the sun's polar distance by taking out the declination for that day and correcting it, for the longitude of the place and the time from noon to obtain the true declination. This declination applied to the angle of 90° (which is sometimes addition and sometimes subtraction) will give the polar distance or the sun's distance from the poles; then add together the altitude, latitude and polar distance to obtain the sum; halve this sum, and from this half sum subtract the true altitude and note the remainder; then proceed to find the log secant of the latitude, log co-secant of the polar distance, log co-sine of the half sum, and log sine of the remainder; half the sum of these logarithms will correspond to the apparent time of day in the hour column; to this apparent time apply the equation of time, and it will give the mean or true time of day. I then proceed to correct the watch, having noted the time on taking the altitudes, and the difference between the true mean time, and the time shown by the watch will give the error, fast or slow. Proceed then to find the true time by the chronometer by applying its rate and the difference between the true time of the chronometer and the mean time of the ship, will be the longitude. If in west longitude, subtract the ship's time from the chronometer; if in east longitude, subtract the chronometer time from the ship's time, and it will give the longitude in time; this I turn into degrees, miles, and proportional parts of a mile by the aid of table 21st constructed for this purpose. In regard to the corrections used in this problem, it is of great importance that they should be correct, for an error in them will affect the longitude. The apparent time obtained by the log sine is the apparent noon shown by the sun or the passage of his centre over the meridian of any place. The difference between apparent and mean time is called equation of time, which is owing to the unequal motion of the earth in its orbit, and the inclination of its axis. The equation of time, then, which is simply the difference between sun and clock time, being applied to the apparent time, will give the mean or true clock time of the place.

The chronometer is a perfect clock, showing the true time at Greenwich, from which all longitude is reckoned, and has a rate or error which is fast or slow, and which must always be applied to it on taking observation for longitude.

LECTURE No. 6.

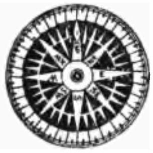
Gentlemen: there is one very essential thing that navigators should be thoroughly familiar with, and that is the knowledge of ascertaining the error or rate of the chronometer; for when the chronometer is to be used on a voyage it must be adjusted, and its rate of going ascertained before sailing. This is done on shore by observing with a transit instrument the time of the transit of the sun or a fixed star on the meridian, and the general method is by using an artificial horizon of quicksilver.

The chronometer having been thus regulated to Greenwich time, and its daily rate of going ascertained, if it should remain unaltered it will show the true time at Greenwich at any moment at sea; but owing to a variety of causes it is liable to get disrated on board ship and its rate of going changed, and in order to ascertain this change at sea, when in the vicinity of some cape or light, whose latitude and longitude are known, the navigator should be able to find this error by a sea horizon. In explaining this problem I shall endeavor to make it so plain that any navigator can understand and avail himself of it.

Now, being in the longitude of some well known cape or light, I take three sights and note the times by chronometer. I then take the mean of these sights, and to this mean I apply my corrections for index, error, dip and hight of the thermometer and barometer to ascertain the true refraction of the place, and also semi-diameter, which will give the sun's true altitude. I ascertain the distance off the light or headland in order to ascertain the parallel of latitude that the ship is on. I obtain the mean time of the ship in the usual manner, turn the longitude of the light or headland into time, add it to the mean time of the ship, if in west longitude, but subtract it if in east longitude. This will give the true time at Greenwich, and the difference between this time and the time shown by your chronometer, will be its error, fast or slow. Now apply the shore rate to your chronometer and note the difference. Should you be in the same place two days after, you can take another set of sights, at or about the same hour, and find the error on that day, and these errors divided by two will be the daily rate of the chronometer.

In regard to the corrections used in this problem, great care should be taken to have them perfectly correct. The hights of the thermometer and barometer MUST ALWAYS be used to ascertain the true refraction of the place of observation, as the refraction is greater in some places than in others, and is always more dense when the heavenly body used is near the horizon. The semi-diameter should always be taken from the Nautical Almanac for the day of the observation, as great accuracy is required in obtaining the true central altitude, and the logs should always be worked for seconds and the mean time ascertained to its smallest denomination.

LECTURE NO. 7.



It is of great importance to the navigator that he should be able to ascertain the variations of the compass in any part of the world, and this can be done by taking amplitudes at sunrise or sunset, or azimuths in the fore or afternoon. Variation, to be sure, is laid down on the charts for different parallels of latitude, but this variation is constantly changing and has been down on the charts for years, so that the accomplished navigator will see the importance of ascertaining for himself the true variation, and if the variation laid down on the charts is correct. And then again it is of the utmost importance to ascertain the local error of the compass which may be caused by iron in some part of the ship or her cargo. I shall first explain amplitudes and the method by which the variations can be ascertained by them.

An amplitude is an arc of the horizon contained between the east and west points of the heavens, or the centre of the sun, or a star at its rising or setting, or in other words, it is the distance of any heavenly body from the east and west point of the horizon, measured on an arc of the circle of 90 degrees. I obtain the magnetic bearings of the sun by compass when he is in one of his diameters above the horizon and read off the degrees. I then work out the true amplitude by obtaining the true declination and entering table 7th of the epitome with the declination at the top and the latitude in the side column; under the one and opposite the other will stand the true amplitude, and the difference between the true and the observed will be the variation, and if the true amplitude falls to the right of the observed the variation will be easterly, if to the left, westerly, and if the declination is north the amplitude must be measured from the east or west towards the north; if south, towards the south. This problem is very easy but of great importance to the navigator. Azimuths are great circles which pass through the zenith and nadir and are perpendicular to the horizon, and are the distance of a heavenly body from the north or south point of the horizon when the body is on that circle. The best time to observe an azimuth is when the sun has obtained half his altitude in rising or setting. I first obtain his magnetic bearing or azimuth by compass, then work out his true azimuth by obtaining his true altitude, polar distance and latitude of ship, and add together to obtain the sum, halve this sum, and from this sum subtract the polar distance; or, take their difference, get the secant of the latitude and altitude, cosine of the half sum and remainder; the sum of these logs will be the cosine or true azimuth, and the difference between this and the observed will be the variation; and if the true falls to the right of the observed the variation will be easterly, if to the left, westerly, and all azimuths must be measured from the north in north latitude, and from the south in south latitude; towards the east in the morning, and towards the west in the afternoon. Azimuths can measure an angle of 180 degrees, while amplitudes can only measure an angle of 90 degrees; by a thorough understanding of these important problems the navigator can ascertain the true variation of the compass in any part of the world.

The local error of the compass, as I said before, is generally caused by iron in some part of the ship or the cargo, therefore always place the compass in the same part of the ship, and find, by actual observation, the greatest deviation arising from the local attraction when the ship's head is directed east or west (this can be done in harbor in the same manner as it is by the naval ships before proceeding to sea), and when the ship's head is any other direction the navigator can find the deviation by entering table first of the epitome, with the heading of the ship as a course, and find the correction in the departure column. One word of caution in regard to using compasses.

Care should be taken to examine the compasses, in order to ascertain whether they are not affected by something on board the ship. When the compass is in use be careful that the lubber's point be placed perpendicular to the fore side of the binnacle, and when lying in port and the compasses not in use, the compass card should be taken off the spindle point and wrapped together in pairs in dry brown paper, with the north point of one to the south point of the other, and kept at a distance from other pairs, which will improve their magnetic virtue.

From the above considerations you will perceive how important a matter it is to be enabled to detect and rectify the above errors and have a thorough understanding of navigation.

LECTURE No. 8.

Gentlemen: the importance of a thorough understanding of the finer branches of navigation, such as working the moon and planets, can only be appreciated by those who have been obliged to make a European passage without seeing the sun for weeks; and the object of this lecture will be to explain the best method of obtaining the latitude of the ship by meridian altitude of the moon, and a simple rule for the same.

In the first place it is necessary to obtain the meridian passage of the moon for the place of the ship, which is done by entering the Nautical Almanac, and find the moon's passage for that day at Greenwich and her passing the meridian the next day, and the difference between these two times, which is found at the top of table 28, under which and opposite the longitude of the ship will stand a correction to be applied to the time of passage at Greenwich to obtain her passing the meridian of the ship.

Having obtained the hour of her passing the ship, I obtain her altitude by the sextant, augment the semi-diameter from Nautical Almanac, and apply it to the altitude, subtract the dip to obtain the apparent altititude, find a correction for parallax and refraction, by means of table 19; this correction must in all cases be subtracted from the standing correction 59′ 42″, the differences of which must be added to the apparent altitude, to obtain the true altitude. This true altitude subtracted from the angle 90° will give the zenith distance; correct the declination in the usual manner and apply it to the zenith distance; if of the same name, add them; if of different names, subtract them, and the result will be the latitude of the ship at the hour of observation. This problem is of great importance to the navigator, a thorough understanding of which will enable him to obtain his latitude at night, and by using it in Sumner's method he may also obtain his longitude and his bearings and distance off the land.

Lecture No. 9.

In this lecture I shall explain a very important problem—how to obtain the longitude of the ship by the moon. In the present improved state of the naval Nautical Almanac we can easily find the moon's right of ascension and declination for the time at Greenwich, and even without a chronometer the time at Greenwich can be obtained, if we know the longitude of the ship, as well as the mean time at the place of observation, by a watch; for by adding the longitude in time to the time by watch, if in west longitude, or subtracting it if the longitude is east, we shall obtain the corresponding time at Greenwich. Great accuracy is required in an observation of this kind in computing the time at Greenwich, for an error in this will affect the moon's right ascension and declination, which vary rapidly. Right ascension often 3″ in one minute of time, and declination 15″ in one minute of time.

In taking an observation note the time by a chronometer; at the same instant take from the Nautical Almanac the sun's right ascension, moon's right ascension, moon's declination, moon's horizontal parallax, moon's semi-diameter, which must be augmentated and added to it. To the observed altitude apply the moon's semi-diameter and subtract the dip; to obtain the central altitude, add the correction for parallax and refraction (which correction is found in table 19) by subtracting the tabular number corresponding to the altitude and horizontal parallax from the standing number of 59′ 42″, the correction so found to be in all cases added to the central altitude to obtain the correct altitude, then bring forward the latitude to the time of observation. Obtain the polar distance in the usual manner, add together the corrected altitude, latitude and polar distance to obtain their sum, halve this sum, and from this half sum subtract the moon's true altitude for a remainder, get the secant of the latitude, co-secant of the polar distance, cosine of the half sum, and sine of the remainder, half the sum of these four logarithms will correspond to time in the hour angle column, apply the moon's right ascension, the sum or difference will be the right ascension of the meridian; from this subtract the sun's right ascension (increased by twenty-four hours if necessary), the remainder will be the apparent time of the ship; to this apply the equation of time, and it will give the mean time of ship at the place; and the difference between this mean solar time and the time shown by the chronometer at the time of observation will be the longitude in time, which is turned into degrees, minutes and seconds by table 21, and will be the longitude of the ship at the place of observation. Sumner's method may also be worked by the moon, and the navigator be enabled to ascertain his true position at any time of night.

ERRATA.

Example 1st, page 40, for 29 nautical miles, read 20.1 miles.

Example 2d, page 40, for 31 nautical miles, read 22.5 miles.

Velocity of sound, page 42, for 8¾ nautical miles, read 6.3 miles.

Page 43. To find the Index Error, for one half the difference of the two readings, read, the difference of the two readings will be the Index Error.

Page 47, question 4th, for multiply, read divide.

Page 84. For sometimes addition and sometimes subtraction, read sometimes added and sometimes subtracted.

Page 46. Days Work. In remarks, read, latitude left yesterday noon was 13 degrees, 25 mins., N. Longitude 30 degrees, 15 mins., W. A current setting 1 mile per hour, E. ½ N. Variation of the compass, 1 ¼ points W.

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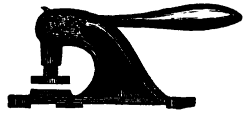

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